SOCIAL STRUCTURE AND THE CHOICE OF CROPPING TECHNOLOGY: INFLUENCE OF PERSONAL NETWORKS ON THE DECISION TO ADOPT CONSERVATION TILLAGE

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EXECUTIVE SUMMARY

Objective

This report employs a multifaceted approach to examining the decision framework of farmers in relation to the decision to adopt or not to adopt conservation tillage. Responses from a representative cross-section of 259 farms surveyed in 1988 in the SWEEP project area are compared to those from a second, nonprobability sample of 55 known conservation tillage adopters for the purpose of examining the relative importance of various on-site, economic, sociodemographic, attitudinal and social network influences leading to the adoption of soil conservation practices.

A distinguishing aspect of this research is the focus of the examination on the farmer's social frame of reference constituted of family, friends and acquaintances to whom he may turn for information or guidance concerning the choice of cropping technology. In this regard we examine both the membership of this network and its structure. The membership of the network, ranging from spouse, through other family, friends, neighbors, and farm advisors constitute important sources of information on farming to which the operator may turn. In addition, the structure, or form, of this network facilitates or impedes the receipt of information concerning innovative farming practice.

Thus the research goals are: 1) to provide evidence of the influence of the structural characteristics of the farmer's communication network in enabling the diffusion of innovation of conservation tillage; 2) to assess information concerning what actors typically constitute the reference group of farmers with regard to decisions on tillage and other farm practices; 3) to assess the relative influence of social, economic, site and cognitive factors in leading to the adoption of new cropping technologies; 4) to compare known adopters with the general cash crop farming public of south-western Ontario on farm and operator characteristics; and 5) to estimate the relative rates of adoption of conservation tillage and other conservation practices among rowcrop farmers during the 1987 growing season.

SWEEP

Funding for this research was provided by a grant from the Socio-Economic Analysis subprogram of the Soil and Water Environmental Enhancement Program (SWEEP). SWEEP is a $30 million jointly funded federal-provincial program intended to reduce phosphorous loadings from non-point cropland soil erosion to Lake Erie by 200 tonnes annually by 1990. The Socio-Economic Analysis subprogram funds projects to evaluate the impact of SWEEP programs and to investigate the conditions under which farmers may choose to adopt conservation forms of farming.

Methodology

A two stage sampling plan was employed to select farms from the SWEEP project area for participation in a comprehensive survey of rowcrop farming practices. At the first stage a probability sample of cash crop farm operations was selected using conventional proportionate stratified, random sampling procedures. A random sample of 497 farms stratified by farm size and county location was drawn from the population of grain corn operations in the twelve counties of the SWEEP project area. Then, on the assumption that such a sample would provide too few farms on which conservation tillage was actually practiced, a second, smaller sample was selected made up of 85 farmers previously identified as using conservation tillage.

The 582 sampled farms were surveyed by mail using a survey instrument comprising more than 200 questions for which information on the following topics was requested: 1) farm characteristics, 2) household composition, 3) soil and erodibility conditions, 4) farming practices, 5) attitudes, values and beliefs, and 6) personal network. With three follow-ups mailings to encourage participation, 350 questionnaire from the 582 originally mailed were returned, for an overall response rate of 60.2 percent. Following exclusions for ineligible and uncodeable responses, the analysis group constituted 314 farms -- 259 farms from the probability sample and 55 from the conserver sample.

Findings

1. Farm Characteristics

A sampling objective was to select farms which were mainly row crop operations. Nearly 93 percent of the farms in the probability sample report producing corn, and 74.4 percent produce soybeans. There were no statistically significant differences between farms in the probability sample and the conserver group with respect to the type of products being farmed. However, the farms of the conserver sample are substantially larger than those in the probability sample, averaging 609 acres versus 339 in the probability sample.

The conserver sample farms were also somewhat more likely to be operated with another family member, not their spouse, or for the legal status of the farm to be a corporation, while self-owned, or ownership with spouse was more common in the probability sample. Most farmers, however, share ownership with at least one other. Few respondents to this survey, only 3.8 percent, reported renting or leasing their farm.

Once the difference in size of farms between conservers and the probability sample is taken into account there is no difference between farms in the two samples in terms of farm assets. However, the conserver farms had significantly more debts, even in consideration of the larger average sizes of these farms. The average debt to asset ratio across all farms in this survey is 34 percent, somewhat in excess of the thirty percent often seen as an acceptable debt to asset balance. Further, the conserver group had significantly lower returns on investment from their farming

operations in 1987 in comparison to the farms of the probability sample. On balance the data on the financial aspects of the farm provide little support for a hypothesis that some farmers are conserving because they ar financially better off.

2. Operator/Household Characteristics

There were no differences between the farms of the conserver group and the probability sample in terms of number of people in the household, or the age the operator began farming, years of experience, how long the farm has been in the family, or the importance of off-farm income to the operation of the farm. Operators in the conserver group had more years of schooling, 13.3 years on average, versus 11.7 years among operators in the probability sample. Those in the conserver sample were younger, although the difference is not statistically significant.

There are some differences between the probability and conserver group with respect to what are the future plans for the farm. Over seventy-two percent of the operators in the conserver group predict that the farm will remain in the family and be farmed, while 56.6 percent of the probability sample claim this, with the remainder believing the farm will be leased or sold.

3. Soil Characteristics

The survey asked respondents about soil conditions on their farms and the existence of various types of erosion. Problems of water erosion and other soil problems are far more likely to be reported on the farms of the conserver group than the probability sample. Compared to farmers in the probability sample, operators in the conserver sample more often report their farms to have finer soil types, steeper and longer slopes, more soil erosion potential, more severe damage from erosion, and greater likelihood of both poor soil structure and soil compaction.

The operators in the conserver group were also more likely to admit their own farming practices to be contributing to soil erosion. In general, the conserver group had a greater tendency to recognize the potential for erosion, while ascribing personal responsibility for its existence. Only on-site inspection (not conducted) can ascertain whether the differences in the erosion levels of the conserver and the probability samples are actual or are simply perceived. However, it is likely that the farmers in the probability sample do not practice conservation as frequently as those in the conserver group because they are less able to recognize when it is needed.

4. Conservation Practices

The survey also examined the tillage and cropping practices used by operators in 1987 for evidence of conservation forms of farming. On this evidence there is some basis for optimism concerning the potential for soil conservation in Ontario. Although 86.5 percent of the farmers in the probability sample reported using the conventional moldboard plough in the fall, a

surprising proportion, 47.6 percent, also reported using reduced tillage on some or all of their fields. Almost one-third of cropland for harvest for this sample, 31.3 percent, was affected by these methods. For the conserver sample, more than one-half, 51.9 percent, used conventional tillage on part of their farm in 1987, while 59.3 percent used reduced till, 22.2 percent used ridge till, 27.8 percent practiced no till, and 31.5 percent used modified no till.

With the two samples combined, 44.6 percent of respondents reported using only conventional tillage in 1987. A further 36.3 percent used some combination of conservation tillage and conventional tillage, and 19.1 percent used only conservation tillage during 1987. Among farmers in the probability sample, 51.4 percent used only conventional tillage, while 35.7 percent combined conventional tillage with conservation tillage, and 12.9 percent used only conservation tillage.

Overall, nearly one-half of the farms in the probability sample, 48.6 percent, reported using some type of conservation tillage on their farms in 1987, and about one in eight farmers reported using only conservation tillage. In addition, 52.2 percent of these farmers reported leaving significant crop residue following planting in 1987 (versus 83.6 percent in the conserver group), with 37.8 percent of the cropland in harvest for that year being affected.

5. Attitudes

Environmental attitudes can be important pre-determinants to conservation behaviour. While in the soil conservation field most interest has been paid to factors involving the financial incentives for conservation, there is significant doubt that conservation will ever be seen by the majority of farmers to be financially attractive. Hence attempts to make conservation financially viable through government programs involving subsidies may be misdirected. While such programs may encourage farmers to adopt conservation, they also imply that the sole basis for deciding to practice conservation rests on its financial merits, while at the same time suggesting the government will accept responsibility for ensuring conservation is financially worthwhile. What this ignores is an approach to conservation which involves an individual's long-term willingness to prevent soil loss through conservation which is based on an ethical and moral commitment to the land, and which is practiced in spite of the extra effort and financial sacrifices which may be involved.

The survey found evidence that factors involving beliefs about soil loss, and attitudes about conservation and land stewardship were important to the farmer's decision to practice or not to practice conservation. There were statistically significant differences between the conserver and probability samples on a number of such beliefs, as well as the intention to practice conservation. Thus, on average, the conserver group was more likely to believe in the existence of soil loss problems in Ontario, while denying that farmland is mainly an economic commodity, or that the government, or other farmers, should be mainly responsible for solutions to soil loss problems. Farmers in the conserver group also saw themselves as being innovative with regard to new farming practices, in addition to believing that the overall benefits of conservation would,

in the long run, outweigh its shortcomings, while stating they held a moral obligation to protect the land, and being committed to soil conservation through the intention to practice it.

The analysis also showed a relationship between these attitudinal and belief dimensions and the farming practices of operators. The majority of the attitudinal and belief factors were related to the intention to practice conservation, in addition to predicting the likelihood of having used conservation tillage in 1987. Further, farmers who felt that conservation tillage was a bad idea from an economic perspective, were those who were least likely to try conservation tillage, while those who believe in its long-term benefits and need were those who were most likely to practice it, or want to. It is also the case that the geographical conditions of the farm with respect to soil and slope conditions, and the perceived evidence of soil loss on the farm, were positively related to the practice of conservation. This points to a need for the development of programs to help farmers recognize the existence of soil erosion on their own farms. The survey findings suggest that farmers are often committed to conservation, but are inhibited from practicing it by being unable to recognize when it occurs on their own farms.

6. The Social Network

The notion of the social network in the context of adoption of conservation tillage adds a further dimension of understanding to the problem of how the decision to adopt conservation tillage is made. The idea that the social network may be important with respect to the farmer's decision to adopt or to not adopt conservation tillage is straightforward. Since before any change in farming practice can be expected the farmer must first receive information about the practice, it is through the social network that new information will be channelled.

Certain aspects of the network may facilitate more effective communication. These include the farmer's location with a sphere of acquaintanceship, as well as the size of the network and its density (proportion of reciprocal ties). Dense networks provide greater opportunities for communication transfer since there are more communication paths. On the other hand, dense networks may also be more "closed", to the extent that their tightly interlocking natures can prevent entry of innovative ideas. Finally, when dealing with innovative, or risky, new farming technology, there is likelihood that individuals with whom the farmer has a "weak" link will serve as a better source of information than with those with whom the link is "strong".

This latter idea centers on the understanding that each farmer's network may be differentiated according to both 1) degree of homophily (similarity) between members of the network, and 2) level of attraction (strength of tie) between members. Thus homophily and close attraction facilitate effective communication, while also acting to prevent new ideas from entering the system. Alternatively, heterogeneity within networks, and weak ties, give the system openness, enabling communications on farming innovations to flow freely.

Responses to the survey suggest the majority of farmers feel their friends and neighbors want them to practice conservation, and there are apparently few internal divisions within

households to prevent this. In these respects both the conserver and probability samples are very similar. These factors, in addition, are related, weakly, to the farmer's intention to practice or not to practice conservation.

On the factors relating to the sources of information seen as important with respect to deciding on farming practices, there are no differences between the responses of the conserver and probability samples. The most important source of information is the farmer's own personal experience, followed by neighbors, the farm media, government and educational agricultural specialists, representatives of commercial firms, farm organizations, family members and one's spouse.

With respect to the personal network, the average size of the networks of the conserver sample is significantly larger than those of the probability sample. This is consistent with network theory generally which argues that larger networks provide more sources of information, and more channels along which it can be communicated, therefore facilitating the diffusion of innovation. Respondents in the conserver sample also had known members in the network for a shorter period of time, but there were no significant differences between the two samples concerning the frequency of interaction between network members, or their occupations. The majority, 64 percent, of network members are active farmers, followed by representatives of commercial or financial agencies, and government agricultural specialists. A relatively high percentage of the network members in both samples, over 40 percent, are people who either practice conservation or who belong to a farm organization which supports it.

The size of the network is also positively associated with the likelihood of having used conservation tillage in 1987, as well as with the intention to practice conservation and with the perception that soil erosion is a problem on the farm. Larger networks are also positively associated with younger and better educated farm operators, who have more debts, less returns on investment, and smaller farms. The density of the network is inversely related to membership in the conserver sample (nonsignificant), as well as with conservation tillage in 1987, and with intention to practice conservation, and the perception that soil erosion exists on the farm. Thus it seems that larger networks encourage conservation, while those which are dense inhibit it, either by being more "closed" and preventing the entry of information, or by being comprised mainly of homophilous relations acting to resist ideas on novel farming techniques.

Closer inspection of the individual networks of farmers reveals that in terms of whom the farmer turns to most often, and mentions as most important, when seeking information on farming matters, it is likely to be another farmer. However, if the network contains a known conserver, or someone who is a member of an association which promotes conservation, then this person is likely to be referred to. On the other hand, when it comes to deciding something on the farm, the network, or reference group to whom the operator turns, is very likely to be comprised mainly of family, kin and other farmers, all individuals with whom the farmer, on grounds of obvious similarity, is strongly connected. Thus if the issue is whether to adopt a new and innovative farming practice, such as conservation tillage, networks comprised of member similarity and strong ties tend, on the whole, to counteract the chances of adoption.

Conclusions and Recommendations

On the basis of these findings, the following conclusions are warranted:

1. The decision to adopt conservation tillage is multi-faceted. Across the range of dimensions investigated it is almost always the case that one or several factors stand out to distinguish members of the probability sample from the conserver group, or to identify conservers. Some of these --education, age, farm size -- are already widely known from the forty year research tradition on diffusion of innovation. Other factors, particular those relating to attitudes, social normative beliefs, and network factors, are much less often recognized. However their relationships with adoption were, in several cases, larger than the more commonly cited predictors of conservation practices. Thus, farmers make up their minds to practice conservation, or not to practice it, based on many things, suggesting the need for the complexity of this decision framework to be taken into account in the development of agricultural programs.

2. Conservation adoption is unpredictable. In spite of a number of significant associations across several dimensions, the correlations are, for the most part, not sizeable. Correlations in the range of .12 to .20 are common and, while statistically significant, can hardly be regarded as large. On these grounds it should be noted that identifying conservers on the basis of farms, or socio-demographics, or financial situation, or beliefs and attitudes, or social networks, or anything else, is never going to be easy.

3. There was little to suggest the financial conditions of farms are related to conservation. Large farms are more likely to practice conservation, true, but several financial indicators were unrelated to conservation adoption, while adopters also had significantly higher debts and lower returns on investment. However, the one factor which strongly predicts the intention <u>not</u> to adopt conservation tillage was the belief that such a practice would be uneconomical.

On grounds of these findings it may be concluded that programs to encourage conservation based on its questionable financial benefits are misguided. It often appears that in developing programs to promote soil conservation planners have assumed the need to convince farmers of its financial benefits. However, an important factor predicting adoption of conservation practices in this survey was the farmer's <u>moral</u> commitment to conserve, and it is notable that such a factor is additionally inversely related to the belief that conservation is uneconomical. Soil conservation in Ontario may in the long run be better served by replacing an emphasis on economic returns with one which stresses land stewardship.

4. There may be more farmers in south-western Ontario practicing conservation than was previously believed. Among the probability sample 12.9 percent of farmers reported using only conservation tillage, and a further 35.7 percent combined conventional tillage with conservation tillage. Further, 44.1 percent of the farms in this survey reported either now practicing conservation tillage, or intending to practice it in the near future.

Still, it is also the case that the great majority of respondents, 86.5 percent, did use the moldboard plough in the fall on at least some portion of their farm in 1987. On balance it can be concluded there is some evidence of increased conservation occurring in south-western Ontario farming, and a willingness by farmers to do more.

5. A factor which appears consistently related to the likelihood of adoption of conservation forms of farming is the farmer's perception that soil loss is occurring on the farm. The belief that soil loss is occurring on one's own farm is a necessary condition for taking steps to prevent it. However, farmers cannot believe in soil loss until they experience it, and cannot experience it until the phenomenon is understood and recognised. If more farmers could be shown how to recognize soil erosion and to estimate its cumulative effects, they would believe in soil erosion and practice conservation.

6. An important goal of this research was to investigate the influence of the farmer's social network on the decision to adopt or to not adopt conservation tillage. In this regard the findings are suggestive, but not conclusive. The structural properties relating to the size and density of the network appear to be related to the dissemination of new information, as well as influencing the network's receptiveness toward innovative farming technology. The networks in the sample are characterized by highly homphilous and strong ties, properties which may impede entry of novel information. However, comparisons between the networks of adopters and nonadopters revealed little which distinguishes their behaviours, excepting the networks of adopters were larger. While the findings from this approach are not conclusive, it should be understood that these network variables introduce a new level of analytical complexity, and with continued investigation are still potentially rich in their ability to explain conservation adoption.

Social Structure and the Choice of Cropping Technology: Influences of Personal Networks on the Decision to Adopt Conservation Tillage

1.0 INTRODUCTION

This report investigates the decision process involved in the farmer's intention to adopt conservation tillage. A distinguishing aspect of this approach is that the analysis places particular emphasis on the farmer's social framework of reference and its influence on the adoption or failure to adopt conservation tillage. Thus our interest is on examining how social structure constituted in the individual's personal network of family, friends and acquaintances affects decision-making on farm practices. To date a number of surveys, involving both Canadian and American farmers, suggest that while, by and large, farmers are aware of the problems of soil erosion, in general, and approve of conservation practices to control it, they are frequently reluctant to themselves engage in such activities (Christensen and Norris, 1983; Culver and Seecharin, 1986; Wall, et al., 1985; Ervin and Ervin, 1982). To this point there is a growing literature identifying many of the obstacles to the more widespread use of conservation (Nowack, 1983, 1985; Napier, et al., 1984; Lovejoy and Napier, 1986; Culver and Seecharon, 1986; Seitz and Swanson, 1980; Ervin and Ervin, 1982). This literature generally complements and extends the quite sizeable research tradition in rural sociology on diffusion of innovations. This tradition has, for over forty years, sought to identify features of farmers and their operations facilitating early implementation of new farming technology (Ryan and Gross, 1943; Lionberger, 1960; Rogers, 1983).

Consistent with the findings from diffusion research generally, the findings relating to the adoption of conservation cropping technology can be classified according to economic, sociodemographic and psychological factors. Thus, past research has shown adoption to be positively correlated with farm size (Heffernan and Green, 1986; Napier, et al., 1984), and with farm income (Cancian, 1967; Boyd, 1980; Frey, et al., 1979; Gartell and Gartell, 1985), while also being more common among operators who are in partnership or who are otherwise in a shared ownership arrangement (Carlson and Dillman, 1983), and by farmers who are owner-operators rather than tenants (Albrecht and Thomas, 1986; Bultena and Hoiberg, 1983; Lee, 1980, 1983; Frey, 1952; Dillman, et al., 1978; Bromley, 1980; Ervin and Ervin, 1982). Further, conservation tillage is frequently negatively associated with operator age (Napier, et al., 1984; Bultena and Hoiberg, 1983), although older operators having a son or daughter who will inherit the farm also are more likely to be adopters (Carlson and Dillman, 1983). Non-adopters tend to be risk-aversive (Ervin and Ervin, 1982), to deny the existence of erosion problems on their farms (Nowack, 1983), and to be less likely to hold a conservation ethic (Ervin and Ervin, 1982).

As well, there are regional and national differences. Bultena and Hoiberg (1983) report an adoption rate for conservation tillage of 56.6 percent among a random sample of Iowa corn and soybean farmers, while Magleby, et al. (1985) estimate an overall rate of adoption in the United States of 20 percent, with regional rates ranging from a low of 1.6 percent in the Pacific region, to 26.9 percent in the corn belt. In contrast, precise estimates for south-western Ontario, which are just becoming available, tend to be lower (Ketcheson and Stonehouse, 1983; Culver and Seecharin, 1986). Nevertheless, an encouraging potential trend has been reported by Coleman and

Roberts (1987) who estimate that 20 percent of south-western Ontario farmers may have changed their primary tillage practices over the last five years, and 30 percent of these report doing so in order to alleviate soil loss. Still, 74 percent of the farmers in this study report using the moldboard plough as their principal tillage implement, in spite of some notable levels of adoption for some counties in the use of the modified moldboard plough and other soil saving devices which range as high as 40 percent (Coleman and Roberts, 1987: 52-53, Table 11). An overall adoption rate for conservation tillage of 17 percent in the south-western Ontario region is considered to be consistent with meeting Ontario's objectives to cut phosphorous loadings to the Lake Erie basin by 300 tonnes annually under the Canada-Ontario Agreement on Great Lakes Water Quality.

While both financial and ecological conditions of the particular farm must play important roles in the decision to adopt, or not to adopt, conservation tillage, what is clear from the diffusion research is that the choice of adoption cannot be accounted for solely on grounds of financial or geographical imperatives. Social factors influence the opportunity to learn about the new technology while helping to shape the individual operator's attitudes and intentions toward it. Still, while there undoubtedly exists a complex interplay between site specific, financial, psychological, family and other social and nonsocial conditions with respect to the farmer's choice of cropping technology, it is not understood what is the relative influence of these various factors. The present research seeks to address this question. In particular our approach draws upon recent developments in the field of social networks to determine how decisions concerning the adoption of cropping technology are influenced by aspects of the farmer's network of friends, family and acquaintances with whom he communicates while deciding on farm practices. The aspects of this

network which constitute important components of the decision process are hypothesized to involve not only its membership, but also its structure involving the form and quality of linkages between members, and the individual operator's position and status within this circle of attachments.

1.1 Network Research

The essence of the diffusion of an innovation is the human interaction through which one individual communicates a new idea to one or more individuals (Rogers, 1983: 166, 170). Any given individual in a system is likely to contact certain other individuals, and to ignore many others. As these intergenerational communication flows become patterned over time, a communication structure emerges which is predictive of behaviour. Basically, network analysis describes these linkages in an interpersonal communication structure. Network analysis is therefore a method for identifying the communication structure in a system (Wellman, 1983; Knoke and Kulinski, 1982; Berkowitz, 1982).

Network analysis starts with the simple but powerful notion that, to be understood, behaviour must be examined within the social context in which it occurs. Thus, it deemphasizes the analytical focus in which the individual is treated as the unit of analysis and behaviour is seen as the outcome of egalitarian, rationalistic and voluntarily determined choices. Rather, it shifts the unit of analysis from the individual to the network itself and concentrates on the network as comprised of a set of asymmetric ties binding individuals together in the hierarchical structure as being the basis for much behaviour. Network analysis searches for deep structure -- regular

network patterns beneath the often complex surface of social systems. These patterns are described and used to explain how network structures constrain social behaviour and social change.

It is the assumption of network analysts that behaviour is socially constructed as an outcome of relationships with others. The normative basis of behaviour by which action becomes self-activating as a result of the internalization of normative standards and values is facilitated or impeded depending on the network. In this sense, the decision of the farmer concerning the choice of cropping technology is never made in isolation. Each farmer is located within a group, uniquely comprised, constituting an hierarchically arranged social network facilitating the functions of communication, social support, social reference, the internalization of standards of farming, and providing both a source of new knowledge and feedback on past actions.

Information on new technology, such as conservation tillage, comes largely from a circle of individuals on which the farmer relies to learn about and evaluate new farming practices. The influence of the network may frequently be direct in the sense of providing communication and assessment of alternative technology, but as well may be more subtle in exerting influence in relation to the statuses and strengths of association which exist between members of the network. Thus the final decision may be either "rational' in the economic sense that it seeks to maximize farm profits and long-term sustained yield, or it may be "irrational" in the sociological sense that non-economic considerations relating to the statuses, social power and attractiveness of various group members influences how new information is acquired and regarded. It is assumed that with

respect to important farm decisions involving the choice of cropping technology both types of information are sought. On a structural level the form and complexity of the network, and the location of the farmer within it can either facilitate or impede the flow of information, knowledge and assessment.

In summary, this research seeks to: 1) examine evidence of the influence of the structural characteristics of the farmer's communication network in enabling the diffusion of innovation on conservation tillage, 2) provide information concerning what actors constitute the reference group of farmers with regard to decisions on farm practices, and 3) assess the relative influence of social, economic, site and cognitive factors in leading to the adoption of new cropping technologies. Thus this research complements other diffusion research which has concentrated on the individual as the unit of analysis. However, by focusing on the context within which farming decisions are made, this analysis attends to the transactional and relational aspects of human communication on diffusion of farming innovation, which to this point has been overlooked.

2.0 RESEARCH SETTING

2.1 Rationale

Over the past 20 years intensive crop production in south-western Ontario has led to serious soil loss and environmental damage. Erosion is estimated to have resulted in crop reductions of as much as 30 percent, while costing Ontario agriculture $68 million annually and reducing net farm incomes by an average 10 percent (Driver and Wall, 1982). In addition, soil erosion contributes to phosphorous loadings to the Great Lakes resulting in significant environmental damage (International Joint Commission, 1978; Driver and Wall, 1982). In 1972 and 1978 Canada and the United States signed the Great Lakes Water Quality Agreement to improve water quality in the Great Lakes, and in 1983 signed an amendment to this agreement calling for reductions in phosphorous loadings to Lake Erie by 2,000 tonnes per year. This was followed by the Canada-Ontario Agreement on Great Lakes Water Quality and the commitment to reduce phosphorous loadings to Lake Erie by 300 tonnes annually by 1990. Two-thirds of this reduction is being met through programs to reduce nonpoint cropland erosion in south-western Ontario.

The Soil and Water Environmental Enhancement Program (SWEEP) is a $30 million jointly funded federal-provincial program designed to meet the Canadian objective of reducing phosphorous contamination of Lake Erie. The program is specifically designed to reduce phosphorous loadings in the lake Erie basin due to cropland run-off, and to improve the productivity of southwestern Ontario agriculture by arresting soil erosion. These goals are being undertaken through a series of subprograms offering assessment, technology development,

selected watershed demonstrations, an information centre, and technical assistance and subsidies to farmers wishing to improve soil conditions. In addition, the Socio-Economic Analysis Project funds projects to evaluate the impact of SWEEP programs and to investigate the conditions under which operators may choose to adopt conservation forms of farming.

The present project on diffusion of innovation and social structure is funded through the Socio-Economic Analysis Project of SWEEP for the purposes of discovering the social, economic and site-specific conditions most amenable to the adoption of conservation tillage. The study compares survey responses from a representative, random sample of mainly cash crop farmers drawn from the 12 south-western Ontario counties contained in the SWEEP project area with a smaller, nonprobability sample of known adopters from the region. The sampling strategy provides the opportunity to make stable comparisons between farmers who have chosen to adopt conservation forms of tillage (where a random sample alone would, in all likelihood, identify too few) and the general cash crop farming population of the region. At the same time these procedures permit, within bounds of sampling error, generalization of these findings to the population of primarily cash crop farmers in the SWEEP Project area.

2.2 Study Area

The study area includes the counties of Essex, Kent, Lambton, Huron, Perth, Middlesex, Elgin, Oxford, Brant, and the regional municipalities of Waterloo and Haldimand-Norfolk. Since it proved difficult to sample within preselected townships, all of the country of Wellington is included, even though the townships of Minto, Arthur, West Luther and Eramosa are not officially part of the SWEEP target area. For the same reason all of Hamilton-Wentworth is excluded even though the townships of Glanbrook and Ancaster are part of the SWEEP region. In consideration of these inclusions and exclusions, the study's findings are, for all practical purposes, still representative of virtually the entire SWEEP project area.

2.3 Goals and Objectives

The goal of the project was to survey farmers identified as primarily active in rowcrop tillage in the SWEEP project area with the intention of determining: 1) farm and soil characteristics; 2) socio-demographic features of the operator and the family; 3) farming practices for 1987 and prior years; 3) social network factors relating to farm practices and decisions; 4) attitudes, beliefs and values concerning the existence of soil erosion problems on the farm, commitment to soil preservation, and knowledge and opinions on conservation tillage. Such information allows the following questions to be addressed:

1. The comparison between known adopters and the general cash crop farming public for the purpose of identifying differences in farm and operator

characteristics, farm practices, referent groups, attitudes and commitment to conservation tillage;

2. The estimation of the relative rates of adoption of conservation tillage and other conservation practices among rowcrop farmers in south-western Ontario;

3. The estimation of the relative influence of geographical, economic, social and attitudinal factors in relation to the operator's conservation farming practices;

4. The assessment of several hypotheses concerning the influence of the farmer's personal network in the context of adoption or refusal to adopt conservation tillage. These include examination of the strengths of associations between the members of the network, the general form of the network structure, and the positional and status characteristics of network members in relation to their influence in the operator's decision framework.

3.0 METHODOLOGY

3.1 Sampling Procedures

In order to be assured of drawing an analysis group which was both broadly representative of those farms having significant potential for soil erosion in the SWEEP project area, as well as containing sufficient numbers of adopters of conservation forms of tillage, a two stage sampling plan was developed. At the first stage a probability sample of cash crop farm operations was selected from the analysis territory using conventional proportionate stratified, random sampling procedures. Then, on the assumption that such a sample would probably provide too few farms on which conservation tillage was actually practiced to allow stable comparisons between adopters and nonadopters, a second, smaller sample was selected made up of farmers previously identified as using conservation tillage.

3.1.1 Probability Sample

A requirement of the survey was that it be directed primarily towards farm operations engaged in rowcrop field cultivation during the 1987 growing season. While it is understood that many types of farm operations could benefit from soil preservation through conservation tillage, cash crop field cultivation in products such as grain corn and soybeans is particularly susceptible to soil erosion given the traditional farming practices of fall ploughing using the moldboard plough.

In order for the survey to be representative of such farms a sampling frame was obtained from the Ontario Corn Producers Association (OCPA) based on its membership list for 1987. Membership in the OCPA is automatic for any farm selling grain corn to a licensed grain elevator

in Ontario. Thus the membership of 28,135 for 1987 is broadly representative of all cash crop, grain corn operations in Ontario for that year.

In order to avoid selecting farms which were not primarily involved in cash crop field cultivation, but did grow small amounts of corn for their own use, or as a source of additional farm income, only those farms reporting at least 8 acres of grain corn for sale during 1987 were included. From the 1986 Census of Agriculture (OMAF, 1987) it is estimated there are 15,053 such farms in the 12 counties of the SWEEP project area. This constitutes the target population. Following the exclusion of small grain corn operations, the remaining farms were stratified according to farm size and county location. The sampling procedure then randomly selected a total of 497 farms while at the same time choosing proportionately on the basis of farm size and county. The resulting proportionate, stratified probability sample constitutes an approximate 3.3 percent sampling fraction, and is estimated to be representative of the target population within a margin of error of 4.3 percentage points 19 times out of 20. The breakdown of the sample by county location is contained in Table 3.1.

Table 3.1

Probability Sample by County

County	1986 Agricultural Census		Probability Sample	
	N[1]	%	N	%
Essex	873	5.8	29	5.8
Kent	2114	14.0	67	13.5
Elgin	1102	7.3	37	7.4
Hal.-Norfolk	1087	7.2	36	7.2
Brant	462	3.1	16	3.2
Oxford	1532	10.2	51	10.3
Middlesex	1892	12.6	61	12.3
Lambton	1377	9.1	47	9.5
Huron	1916	12.7	63	12.7
Perth	1490	9.9	49	9.9
Waterloo	656	4.4	22	4.4
Wellington	552	3.7	19	3.8
TOTAL	15053	100.0	497	100.0

[1]Grain corn operations > 8 acres

3.1.2 Conserver Sample

The conserver sample was assembled from names provided during the field stage of our research from interviews with various soil and crop specialists, farmers, farm groups and government agencies. The Ontario Corn Producers Association, upon request, provided a list of 49 conservers known to this agency's staff and board of directors. Another list of 52 names was acquired representing farmers in attendance at a no-till workshop during December, 1987, and a third list contained names of 28 farmers who had responded to an inventory on ridge till

practices conducted by Adam Hayes of the Ridegtown Research Station. To these were added the names of various other individuals brought to our attention during the field interviews.

There was a certain degree of overlap in the names of adopters assembled from these various sources. A number of exclusions were also necessitated for cases in which the farm was outside the SWEEP project area, or it was recognized that the operator was not actually engaged in farming (government representative, retired). Following these exclusions there remained a total of 85 farmers living within the project area who had been identified as involved in conservation tillage. This constituted out target population at this stage. Given that these individuals were not contacted prior to the actual survey in order to ascertain directly the level of their involvement in conservation tillage, the question remained whether these farmers actually did practice conservation, and therefore if the group is a valid one to compare with the probability sample. Inspection of the responses from the fifty-five respondents in this sample who later returned a questionnaire, indicate that in 51 cases (92.7%) the operators either were using conservation tillage on their home farm (48) or had used it on this or another farm (3). In three other cases the operator stated he was definitely planning to use conservation tillage during the upcoming (1988) planting season, and in the remaining case the operator planned to use conservation tillage within the next two years. Given these levels of involvement in conservation tillage, it seems reasonable to regard this sample as comprising genuinely active adopters.

3.2 Sample Survey

The survey was by mail questionnaire sent to the total of 582 farms represented by the two samples. The administration of the survey took place during the late winter and early spring of 1988. The timing, during a period when farmers were making plans for spring planting, was unfortunate but unavoidable. Several delays involving the start-up of the project, followed by more time needed than expected to produce the survey instrument, pretesting and the requirement to acquire several approvals and bilingual translation of all instruments, combined to delay administration of the survey by nearly two months.

Respondents were first contacted by advance letter two weeks prior to the mailing of the questionnaire. This was in order to make them aware of their selection to the sample and the purpose of the survey. The questionnaire was mailed in a package containing a cover letter together with a stamped return envelope and an enclosure sheet providing answers to a number of common questions raised by participants in mail surveys. Respondents were informed of their rights of voluntary participation, confidentiality and the protection and obligations afforded them under the Privacy Act, the Access to Information Act and the ethical guidelines for research involving human subjects of the University of Waterloo.

The survey itself was a printed booklet thirty-three pages long and containing more than 200 questions (Appendix A). The instrument was divided into five sections requesting information for each of the following areas: 1) farm characteristics (size, products, ownership, financial circumstances, soil and slope conditions, erosion problems, erosion control

structures, etc.); 2) farming practices (tillage, seeding, rotation, fertilizer use, tillage and planting implements, etc.); 3) household composition (operator marital status, age, education, experience, income, off-farm employment, household occupant information, etc.); 4) personal network (relationship, familiarity, length of time known, importance, etc.); and 5) attitudes, beliefs and opinions (soil loss in Ontario, conservation tillage, social influence, land stewardship, etc.). While long, the questionnaire allowed the assessment of the several conceptually distinct levels of information necessary in order to allow the later examination of the relative influences of economic, geographic, social and attitudinal factors on the farmer's decisions concerning conservation tillage. Pre-testing, plus review by several soil and crop specialists, suggested that on the basis of the significance of the soil conservation issue and the government and university sponsorship of the research, the survey would be found to be acceptable by the majority of farmers.

The initial mailing was followed by a reminder postcard to all respondents five days later, and then by two mailed followups to nonrespondents at two week intervals. The final followup contained another copy of the questionnaire and a second stamped return envelope. Through these procedures a total of 350 questionnaires from the 582 initially mailed were returned, an overall response rate of 60.2 percent. The response rate for the conserver sample, 76.5 percent, is higher than that for the probability sample (57.3 percent), a not unexpected outcome given the greater salience and importance of the survey topic to the conserver group. From the questionnaires returned, 20 were found to be from ineligible respondents, fifteen were uncodeable, and 1 was received too late to allow its inclusion in the analysis for this

report. This leaves a total of 314 valid cases for analysis -- 259 from the probability sample and 55 from the conserver sample. Further details on the response rate, together with a breakdown by sample and county location for the analysis group, are found in tables 3.2 and 3.3.

Table 3.2
Response Rate by Sample

	Probability		Non-Probability		Total	
	N	%	N	%	N	%
Mailed out	497	100.0	85	100.0	582	100.0
Returned	285	57.3	65	76.5	350	60.1
Ineligible	12	2.4	8	9.4	20	3.4
Uncodeable	13	2.6	2	2.4	15	2.6
Late return	1	0.2	0	0.0	1	0.2
Analysis group	259	52.1	55	64.7	314	54.0

Table 3.3

Analysis Group (N=314) by County and Sample

	Probability		Conserver		Total	
County	N	%	N	%	N	%
Essex	14	5.4	1	1.8	15	4.8
Kent	34	13.1	9	16.4	43	13.7
Elgin	25	9.7	7	12.7	32	10.2
Hal.-Norfolk	17	6.6	3	5.4	20	6.4
Brant	7	2.7	5	9.1	12	3.8
Oxford	32	12.4	5	9.1	37	11.8
Middlesex	34	13.1	5	9.1	39	12.4
Lambton	23	8.9	3	5.5	26	8.3
Huron	33	12.7	9	16.4	42	13.4
Perth	25	9.7	1	1.8	26	8.3
Waterloo	10	3.8	1	1.8	11	3.5
Wellington	5	1.9	6	10.9	11	3.5
TOTAL	259	100.0	55	100.0	314	100.0

4.0 FINDINGS

4.1 Overview of the Farming Operation

In this section we provide an overview of the basic farming operation. The variables to be examined involve factors of farm type, size, ownership, sales and other financial matters, as well as socio-demographic characteristics of the operator and his family, and factors relating to soil and erosion conditions on the farm. At each point a comparison is being made between the the responses provided by the probability sample and the conserver group. The question being addressed by this approach is whether there are notable physical or organizational differences between the farms of the two samples. It is fundamental to the adoption of any conservation technology that structural arrangements of the farming operation are conducive to the decision to employ conservation tillage. In other words, the potential for erosion must exist, it must be perceived, and it must be capable of being acted upon in the context of the farm and the people who live there. The conserver group provides insight into those conditions which are right for the adoption of conservation technology. The question is, do the same conditions apply to the general row crop farming public?

4.1.1 Farm Characteristics

Table 4.1 summarizes differences between the two samples on variables for the size of the farm, principal farm products, and field crop rotations. It should be noted initially that the sampling objective to select farms which rely mainly on row crops appears to have been achieved. Ninety-two point six percent of the farms in the probability sample report producing grain corn, while 74.4 percent produce soybeans. Other field crops are also grown, and many

farms have livestock. However, with the exception of the very small numbers associated with fruit farming, there are no statistically significant differences in the level of various products being farmed between the two samples, and the emphasis is heavily on row crops in both cases.

Significant differences do exist with respect to farm size. The farms in the conservation group are, on average, significantly larger than those in the probability sample while also having more acreage in cropland, more acres owned, more acres leased or rented and more acres in corn than the farms of the probability sample. Such a finding is consistent with other research on the adoption of conservation tillage (Heffernan and Green, 1986; Napier et al., 1984). Presumably, in order to be involved with conservation tillage there is an advantage to having more space on which to implement, or experiment, with this technology or, perhaps, the operator of the larger farm has the bonus of extra income and is better prepared financially to afford the necessary modifications to existing machines or the purchase of new equipment. Whichever is the case, it can probably be said that a larger farm allows greater flexibility when deciding about changes to farming practices. Large farms may also be an indication of success as a farmer, with this being realized partly by a willingness to innovate and take risks, things also associated with the decision to adopt conservation tillage.

The conservation group is also more likely to rotate on row crops, cereals and forage (61.5%) than the probability sample (44.8%), a management practice which is both consistent with efforts to conserve soil as well as probably being more easily achieved on larger farms

with more fields and acres of cropland. Nevertheless, rotation practices are not that different between the two groups. The large majority of farmers in both samples report using crop rotations (92.6%), and in the majority of cases these involve row crops and cereals.

Table 4.1

Description of Sample Farms

Variable	Sample Mean	Probability sd	Conserver Mean	sd	t	Prob.
Acreage						
Total Farm Acreage	339.28	307.61	608.75	621.76	-3.13	.00
1987 Acres in Crops	304.91	298.01	573.29	615.96	-3.15	.00
1987 Acres Owned	227.92	252.35	359.44	234.35	-3.55	.00
1987 Acres Rented	106.19	166.20	241.65	501.24	-1.98	.05
1987 Acres in Corn	138.72	200.80	305.84	415.52	-2.91	.00
Products						
Cattle and Calves	.279[1]	.44	.291	.45	-0.20	.84
Pigs	.182	.39	.236	.42	-0.83	.40
Sheep and Lambs	.027	.16	.036	.17	-0.36	.72
Poultry	.058	.24	.055	.23	0.10	.92
Vegetables	.062	.24	.055	.23	0.21	.84
Fruit	.027	.16	.00	.00	2.68	.01
Grain Corn	.926	.26	.891	.31	0.78	.44
Wheat	.671	.47	.727	.45	-0.83	.40
Tobacco	.054	.22	.018	.13	1.57	.12
Soybeans	.674	.48	.782	.41	-1.71	.08
Other Field Grains	.252	.50	.236	.49	0.25	.80
Other	.458	.50	.491	.50	-0.45	.66
Rotation						
Row Crops	.168	.37	.115	.32	1.06	.28
Row Crops/Cereals	.498	.50	.442	.50	0.74	.45
Row/Cereals/Forage	.448	.50	.615	.49	-2.23	.02
Row Crops/Forage	.054	.23	.019	.14	1.46	.14
Cereals/Forage	.071	.26	.019	.14	2.08	.03
Forage/Pasture	.063	.24	.000	.00	3.93	.00
Other Rotation	.054	.23	.019	.14	1.46	.14
No Rotation	.078	.28	.055	.23	0.64	.52
N	258		55			

[1]Proportion reporting. Proportions do not sum to 1.00 due to multiple products.

Table 4.2 compares the ownership arrangements between farmers in the two samples. The conserver group is somewhat less likely to hold single ownership of the farm, while also being more likely to operate it with another family member, not their spouse, and for the legal status of the property to be a registered corporation. This is also consistent with other research on conservation adoption suggesting forms of farm ownership other than single, private owners (Carlson and Dillman, 1983). Operating a farm with another provides an additional source of information and knowledge on new farm practices, while at the same time "diffusing responsibility" (Darley and Latane, 1968) for the risks being undertaken when new practices are attempted. On the other hand nearly three quarters (73.7%) of the probability sample reported either owning the farm themselves or in conjunction with their spouse. From a network perspective, such arrangements can be regarded as being less conducive to the receipt of new information on farming practices, since there is no legal requirement to consult others on the operation of the farm or, if the other owner is the spouse, there is greater likely of there being similarity of views on practices based on the strong marital bond. Diffusion, to be successful, relies on one's receptiveness towards information with which one was previously unfamiliar, and such fresh ideas stand a greater chance of originating from outside one's immediate family.

On the other hand Table 4.2 also indicates no statistical significance between the two samples on the number of partners the operator shares ownership with. Most farmers share ownership with at least one other. Overall the tables suggests that it is the nature of the relationship between owners which distinguishes the two groups: conservers are more likely to

share ownership with another family member, not their spouse, while other farmers tend to be in partnership with their spouse. As just discussed, there are predictable differences concerning the likelihood of changing farming practices on the basis of where you get your information and who you must answer to.

Finally, it is also the case that there a very few farms in the sample which are owned by outsiders (rented or leased). Only 12, or 3.8 percent, of the survey respondents report such ownership arrangements. While there are proportionately more such farms in the probability than the conserver sample, the difference is not statistically significant ($z = 1.25$, $p = .11$), and in any case the overall size of this group is too small to allow reliable comparisons. Tenure arrangements involving rental or lease of land are often cited as being a disincentive for practicing conservation tillage, but the size of this group in the current sample does not allow adequate investigation of this question. Further study involving a larger sample of renters is necessary.

Table 4.2

Farm Ownership Arrangements

Variable	Sample Probability	Conserver	Chi-square	prob.
Ownership				
Self-Owned	25.5%	16.4%		
	(65)	(9)		
Spousal	48.2	30.9	19.31	.00
	(123)	(17)		
Other Family	22.0	50.9		
	(56)	(28)		
Outsiders	4.3	1.8		
	(11)	(1)		
Legal Status				
Privately Owned	68.6%	50.9%		
	(175)	(28)		
Partnership	21.2	16.4	18.87	.00
	(54)	(9)		
Corporation	10.2	32.7		
	(26)	(18)		
Partners				
None	20.9%	17.3%		
	(53)	(9)		
One	46.5	40.4	1.18	.41
	(118)	(21)		
Two or More	32.7	42.3		
	(83)	(22)		

Table 4.3 compares farms from the two samples in areas of financial structure. Since it nearly unavoidable that the size of the farm is related to its assets and other financial circumstances, and it has already been shown that the conserver group operates significantly larger farms, farm size is being controlled in these models using a two-way analysis of variance to account for variability in assets and other financial variables. Initially it can be seen that once size of the farm is taken into account, there is no significant difference between the conserver and probability samples in terms of reported farm assets. The size of the farm accounts for approximately 32 percent of the variance in reported farm assets ($F=47.00$, sig. $<$ .01, eta-squared=.32), and once this is taken into account no further differences can be attributable to the sample ($F = 2.03$, sig.=.16).

The same does not apply in the cases of two other financial variables reported in Table 4.3, debt and 1987 farm sales. In the case of debt, even taking into account the conserver sample's larger farms, this group still faces significantly larger debt on average than the farmers in the probability sample. The source of this added debt is unclear. However, it is worth noting that it is apparently not the case that this additional financial burden has prevented this group from adopting innovative conservation practices (although it is also true that this may be the source of their additional debt).

For 1987 farm sales there is also a difference attributable to the sample even when the larger farms of the conserver sample are taken into account. In this case, however, the relation with farm size is curvilinear. Small and intermediate sized farms in the conserver group average lower values in farm sales for 1987 than similarly sized farms in the probability sample. However, farms larger than 400 acres in the conserver group made sales which greatly exceeded those made by farms in the other sample, by an increment that is on average nearly 90 percent higher ($493,330 versus $260,680). This in part helps to offset the higher debt of the conserver group, while these factors help to explain why, once everything is added up, and expenses for the year deducted, there are no significant differences in reported net household income for either group or for the size of the farm operation (see the final model on household income in Table 4.3). On balance, therefore, there are no apparent differences between the groups in terms of the reported profitabilities of their farming enterprises.

Table 4.3
Farm Finances by Size and Sample Type

Variable	Description Mean	sd	N	Analysis of Variance Summary
Assets				
< 200 Acres	298.67	252.26	94	F prob.
Probability	298.26	257.36	86	
Conserver	303.13	202.85	8	Size 47.00 .00
200-399 Acres	461.76	280.71	102	Sample 2.03 .16
Probability	450.00	276.80	86	A x B .82 .45
Conserver	525.00	302.21	16	
400+ Acres	747.57	366.23	103	Eta-squared = .32
Probability	705.92	366.67	76	
Conserver	864.81	344.97	27	
TOTAL	508.95	356.18	299	
Debt				
< 200 Acres	64.21	83.07	84	F prob.
Probability	62.62	89.31	77	
Conserver	81.71	84.60	7	Size 32.98 .00
200-399 Acres	188.14	103.93	98	Sample 3.89 .05
Probability	107.37	108.99	82	A x B 1.19 .30
Conserver	112.13	75.39	16	
400+ Acres	261.18	240.27	98	Eta-squared = .26
Probability	231.89	219.34	71	
Conserver	338.22	278.11	27	
TOTAL	148.53	181.80	280	
Sales				
< 200 Acres	94.29	135.62	92	F prob.
Probability	98.75	140.82	84	
Conserver	47.50	35.36	8	Size 31.62 .00
200-399 Acres	139.39	120.43	99	Sample 9.63 .00
Probability	141.07	126.86	84	A x B 8.28 .00
Conserver	130.00	77.44	15	
400+ Acres	323.50	271.40	100	Eta-squared = .26
Probability	260.68	200.47	73	
Conserver	493.33	358.09	27	
TOTAL	188.40	213.89	291	

Household Income

< 200 Acres	49.04	86.99	78
Probability	50.85	90.96	71
Conserver	30.71	12.72	7
200-399 Acres	61.89	89.62	90
Probability	61.53	95.30	75
Conserver	63.67	55.27	15
400+ Acres	67.50	76.23	86
Probability	68.33	78.61	60
Conserver	65.58	76.82	26
TOTAL	59.84	84.49	254

	F	prob.
Size	.88	.41
Sample	.13	.71
A x B	.11	.90

Eta-Squared = .00

The final assessment of the financial situation of the farm is contained in Table 4.4. Here ratios of debt to assets, sales to assets and income to assets have been computed and reported for the two samples. While being somewhat crude from an accounting point of view, these indices can be regarded as roughly representing the levels of debt severity, return on sales, and return on investment for individual farms. These ratios are, perhaps, better indicators of the financial health of the farm than the previously reported raw values on sales, debt and income. From the standpoint of the individual farmer's willingness to participate in innovative conservation practices, it is likely that these are the kinds of financial factors he will review prior to making a decision.

It should be first noted that with respect to two of these ratios, debt and sales, there are no significant differences between the two samples. Overall, the conserver group is not earning more on sales and their debt positions, relative to their higher assets, is not significantly higher than that of the general cash crop farming public. An advantage in any of these circumstances could serve as a basis for explaining the willingness of the conserver

group to engage in conservation tillage, but Table 4.4 does not support such a conclusion. Indeed, their income ratios, or returns on investment, are significantly lower, on average, than is the case for farmers in the probability sample. Further, the average debt ratios for both groups, which are in excess of thirty percent, are in the range for which it is usually felt there exists an unhealthy debt to asset balance. Admittedly these are only crude approximations of actual financial circumstances, which must be based on a careful accounting of the many factors associated with running the farm, but on balance these ratios do provide little evidence to support the conclusion that some farmers are conserving because they are financially better off.

Table 4.4

Financial Ratios

Ratio[1]	Sample Probability Mean	N	Conserver Mean	N	Total
Debt Ratio	.33	230	.38	50	Mean = .34
					sd = .38
	Z = -0.90				Min = 0.00
	Sig. = .37				Max = 2.00
					Mdn = .24
Sales Ratio	.38	235	.45	50	Mean = .39
					sd = .34
	Z = -1.33				Min = .02
	Sig. = .18				Max = 2.33
					Mdn = .30
Income Ratio	.18	203	.13	48	Mean = .18
					sd = .24
	Z = 2.27				Min = .01
	Sig. = .02				Max = 1.67
					Mdn = .09

[1]Ratios of reported debt, 1987 sales, and family income to total value of the farming operation.

4.1.2 Operator/Household Characteristics

Table 4.5 summarizes information from the survey on characteristics of the farm operator. Again there are few differences between the two samples, with the exception that farmers in the conserver group have significantly more years of education (13.32) than those in the probability sample (11.66). This finding is again consistent with previous reports of adopters having more education (Bultena and Holberg, 1983; Ervin and Ervin, 1982). Past studies have also suggested that adopters are, on average, younger than non-adopters, but we cannot generalize such a finding with confidence to the farming population of south-western Ontario, although the differences are in the predicted direction and do approach statistical significance ($t=1.43$, $p=.07$, one-tailed).

The other differences suggested by Table 4.5 have to do with off-farm employment. Among those currently holding an off-farm job, members of the probability sample have held such jobs longer, and work longer hours in them each week. However, there is no difference between the two samples in the likelihood of currently holding an off-farm job, while slightly more than 1/3rd of all respondents do hold such employment.

Table 4.5

Sociodemographic Comparisons for Operator and Household

Variable	Sample Probability Mean	sd	N	Conserver Mean	sd	N	t	prob.
Number in household	3.66	1.4	256	3.92	1.5	52	-1.14	.26
Age of operator	47.33	12.7	246	44.53	9.4	51	1.43	.15
Years of education	11.66	2.8	253	13.32	2.5	53	-4.03	.00
Age began farming	22.44	7.7	247	22.41	6.1	49	.03	.98
Years as main operator	20.74	11.7	229	18.00	10.0	48	1.53	.13
Years farm in family	60.27	41.9	215	60.82	41.0	45	.08	.94
Currently holding off farm job	.35	.48	256	.37	.49	53	.36	.72
Years held off farm job	10.74	9.7	153	6.52	6.40	27	2.17	.03
Hrs/week off-farm	27.56	11.69	79	18.10	14.52	18	2.97	.00
Importance of off-farm income	1.86	.88	248	1.83	.81	52	.27	.79

The household composition of the two samples is also similar. The average household size is between 3 and 4 persons and contains a married couple with children living at home (Table 4.6).

Table 4.6

Marital Status of Operator

Status	Sample Probability %	(N)	Conserver %	(N)	
Single/Widowed	3.9%	(10)	5.8%	(3)	
Married Couple	22.0	(56)	9.6	(5)	Chi-square=6.87
Couple w/Children	65.1	(166)	80.8	(42)	d.f.=4
Single Head w/Child.	1.6	(4)	0.0	(-)	prob.=.15
Multiple Occupants	7.5	(19)	3.8	(2)	

Finally, it is unclear if the operator's future plans for the farm are related to conservation practices, as distinguished by these samples. Table 4.7 summarizes responses to the question of what will happen to the farm once the current operator stops farming. For both samples the majority of respondents predict it will remain in the family and be farmed by a family member. There is more support for this option by members of the conserver sample (72.3% vs. 56.5%), but this is offset by the greater tendency of the respondents to the probability sample to state that, while all or part of the farm will be leased out in future, it will still remain in the family. Approximately one-quarter of all respondents feel the farm will eventually be sold to a non-family member. Previous studies suggest that the operator's future plans for the farm in relation to whether a family member will inherit it, can be a basis for a willingness to practicing conservation tillage (Carlson and Dillman, 1983). However, while on the basis of the sample distinction farmers in the two groups do have different plans for the

farm, approximately three-quarters of the respondents in each case still believe the farm will stay in the family, even if farmed by someone else.

Table 4.7

Future Plans for Farm

Plan	Sample Probability %	(N)	Conserver %	(N)	
Remain in family and farm	56.6%	(147)	72.3%	(34)	Chi-square=5.66
All or part leased	12.4	(31)	4.3	(2)	d.f.=3
Sold	24.7	(62)	23.4	(11)	prob.=.13
Other	4.4	(11)	--	--	

4.1.3 Soil Characteristics

The perception of water erosion problems on the farm is a precondition to the operator thinking about taking steps to arrest them. The survey asked respondents about soil conditions on their farm and the existence of various types of erosion. Since the research procedures did not involve any direct physical measures of soil and slope conditions, or involve other forms of on-site verification of conditions, it must be noted that these self-reports do not necessarily reflect actual conditions. Nevertheless, while such information would be valuable, it should be understood that it is what farmers feel and believe about potential problems that is the impetus for acting to solve them, whether they are true or not.

The question being addressed by the following tables is whether the operator's belief in the existence of erosion potential appears to be related to actions to control it. While this is worthwhile, it is still the case that where differences are identified between the two samples, we cannot be certain whether these are actual or are simply due to the greater sensitivity and awareness of erosion risks among the conserver group.

Table 4.8 describes the soil type reported by operators in the two samples. From the standpoint of erodibility, coarse soils (sand, loamy sand, etc.) have relatively small potentials for causing erosion problems, with "K-factors" from the Universal Soil Loss Equation in the range of .15 - .30 (Wischmeier, 1976; Wischmeier and Smith, 1978). This is followed by fine (clay loam, clay, silty clay, etc.) where K-factors range between .25 and .33, and by medium soil types (silt, loam) with K values of between .31 though .41. In the survey, the predominant soil reported by the conserver group was medium, while for the probability sample it was fine. The difference is statistically significant (chi-square 8.19, d.f.=4, p.=.02), suggesting the conserver group has greater erodibility potential due to soil type than those in the probability sample. The conserver group also reports an important secondary soil type on their farm far more frequently (69.1% vs. 48.6%). Among those reporting important secondary soil conditions, there are no statistically significant differences in the types reported by the two samples, although these do tend to be those soils which are higher in soil erodibility (medium, fine and combinations).

Table 4.8
Soil Type by Sample

Variable	Sample Probability %	(N)	Conserver %	(N)	
Predominant Soil[1]					
Course	11.7	(30)	20.0	(11)	Chi-square= 8.19
Medium	31.1	(80)	43.6	(24)	d.f.=2
Fine	57.2	(147)	36.6	(20)	prob.=.02
Secondary Soils					
			Chi-square= 7.59		
Present	48.6	(122)	69.1	(38)	d.f.=1
Not present	51.4	(129)	30.9	(17)	prob=.01
Secondary Soil Type[2]					
Course	29.6	(50)	31.0	(18)	Chi-square= .275
Medium	23.7	(40)	20.7	(12)	d.f.=4
Fine	23.7	(40)	24.1	(14)	prob.=.99
Organic	19.5	(33)	17.2	(10)	
Other	3.6	(6)	3.4	(2)	
Percentage Acreage for Second Soil					
Course	20.7	(20)	15.7	(5)	ANOVA Summary
Medium	26.4	(16)	26.8	(6)	F prob
Fine	17.9	(13)	19.9	(5)	Sample .19 .66
Organic	12.4	(12)	2.7	(2)	Soil Type 3.63 .00
Other	3.6	(3)	13.3	(1)	A x B .40 .85
Soil Combinations	27.1	(40)	32.7	(14)	

[1] - 2 farms from probability sample report organic soils
[2] - subsample n's may represent multiple responses

Table 4.9 compares reported slope levels and slope lengths between the two samples. There are no significant differences between the two groups on slope levels, although the tendency for the probability sample to report flat slope conditions for the majority of acreage (57.5%) approaches statistical significance (t = 1.86, p. = .06, two-tailed). Overall, the data suggest steeper slopes on the conserver farms, but the differences are not great. On the other hand, the probability sample is more likely to report very short slope lengths (39.1% of acreage vs. 17.6% for the conserver sample), while the conserver sample more often reports long slope lengths (45.6% of acreage vs. 34.2%). Taken together, the data on slope level and slope length favour a conclusion that the farms of the conserver sample have, on average, greater erosion potential due to slope conditions.

Table 4.9
Slope Conditions as a Percentage of Total Farm Acreage by Sample

	Sample Probability			Conserver			t	prob.
Slope Factor	Mean	sd	N	Mean	sd	N		
Amount of Slope								
Flat (0-2%)	57.5	40.3	251	46.6	34.4	55	1.86	.06
Rolling (5-10%)	36.7	38.0	251	45.3	33.7	55	-1.55	.12
Hilly (11-25%)	5.1	14.2	251	6.3	9.4	55	-0.59	.56
Untillable (> 25%)	0.7	3.7	251	1.8	8.6	55	-1.51	.13
Length of Slope								
Very short								
Very short (12-30m)	39.1	43.5	259	17.6	26.6	55	3.54	.00
Short (31-60 m)	7.2	20.4	259	13.8	26.1	55	-2.02	.04
Medium (61-150 m)	19.4	31.9	259	23.1	28.4	55	-0.79	.43
Long (151-300 m)	34.2	39.9	259	45.6	36.3	55	-1.96	.05

Table 4.10 reports the existence of various types of water erosion on farms for the two groups. The questionnaire asked respondents to report on the presence of up to four different types of water erosion: interrill, rill, gully and streambank. Only 3.8 percent of the conserver group reported no water erosion problems on their farm, while nearly one in five (18.4%) in the probability sample report this. Overall, the the average number of problems reported was slightly under two (1.77), but the number of reported problems for the conserver group, 2.32 was higher than for the probability sample, 1.65, and the difference is statistically significant ($t=3.94$, $p. < .01$).

Table 4.10

Presence of Water Erosion Problems by Sample

Number of Problems Named[1]	Sample Probability %	Sample Probability (N)	Conserver %	Conserver (N)	Total %	Total (N)
None	18.4	(44)	3.8	(2)	15.8	(46)
1	30.1	(72)	18.9	(10)	28.1	(82)
2	27.6	(66)	28.3	(15)	27.7	(81)
3	15.9	(38)	39.6	(21)	20.2	(59)
4	7.9	(19)	9.4	(5)	8.2	(24)
Means	1.65		2.32		1.77	
s.d.	1.18		1.01		1.18	
t	3.94					
sig	.00					

[1]Number of water erosion problems named being from slight to severe on this farm: interrill, rill, gully, stream bank, other form of water erosion.

Table 4.11 provides additional information on reported erosion problems on the farms. There are statistically significant differences between the two samples on the severity of both interril and rill forms of erosion, with the conserver group reporting these forms of erosion to be more often severe. In addition, the conserver group reports a greater incidence of problems associated with both poor soil structure and soil compaction. A single item report on the overall severity of water erosion on the farm, which provides a summary indication of the operators's belief in the existence of soil erosion on the farm, is again significantly higher for the conserver group.

The proportion of acreage affected by water erosion, compaction and poor soil structure are all estimated to be higher on the farms of the conserver group than on the farms of the probability sample. On average 25 percent of the conserver group's cropland is estimated to be affected by water erosion, while it is only 9 percent in the probability sample. In addition, the conserver group estimates twice as much cropland, 36 versus 18 percent, to be compacted in comparison with the probability sample, and it estimates twenty-four percent of cropland, on average, to be affected by poor soil structure, while the average for the probability sample is 11 percent.

Table 4.11
Reported Erosion Problems on Farm

Factor	Sample Probability Mean	sd	Conserver Mean	sd	t	prob.
Erosion Factor[1]						
Interill	1.72	.74	2.26	.91	-4.62	.00
Rill	1.80	.78	2.26	.79	-3.88	.00
Gully	1.42	.71	1.59	.96	-1.50	.13
Bank	1.31	.66	1.45	.69	-1.37	.17
Soil compaction	1.83	.84	2.30	.89	-3.63	.00
Poor soil structure	1.53	.75	2.12	1.01	-4.66	.00
Wind erosion	1.59	.74	1.80	.94	-1.78	.08
Overall surface erosion	1.80	.71	2.30	.77	-4.64	.00
% Affected Acres						
Water eroded	.09[2]	.19	.25	.31	-4.67	.00
Compacted	.18	.32	.36	.37	-3.33	.00
Poor soil structure	.11	.26	.24	.32	-2.94	.00
Wind erosion	.12	.26	.20	.33	-1.85	.07
Erosion Indices						
5 item reported erosion[3] á = .81	9.51	3.41	12.19	3.71	-5.21	.00
USL potential scale[4]	18.52	19.65	26.47	23.30	-2.61	.01
Contributing Factors[1]						
Steep slopes	2.03	1.25	2.64	1.18	-3.29	.00
Long slopes	2.13	1.20	2.76	1.20	-3.52	.00
Offsite problems	1.63	.95	1.81	.97	-1.29	.20
Absence of control str.	1.90	1.08	2.09	1.04	-1.22	.22
Tillage practices	2.07	1.02	2.42	1.10	-2.25	.03
Cropping practices	2.19	1.06	2.55	1.03	-2.26	.02

[1]4 item scales: 1 = not a problem; 4 = severe problem
[2]Proportion of total acreage affected
[3]Scale of reported overall erosion, interill, rill, steep slopes and long slopes, scale range 5-20
[4]Universal soil loss equation potential: rainfall x soil condition x slope by length factor

On those factors which are believed to be contributing to soil problems, the conserver group is more likely to cite steep and long slopes and, in addition, to blame their own cropping and tillage practices for erosion problems. Thus the conserver group is both more likely to perceive erosion problems, as well as to ascribe personal responsibility for these conditions to their own farming practices. On the other hand, the probability sample has a greater tendency to deny both the existence of soil erosion problems, and their own contributions to soil problems when they exist. The irony, of course, is that we already know that the great majority of the farmers in the conserver sample have taken steps intended to solve erosion problems, and in spite of this, on average, still hold themselves responsible for soil problems on their farms.

From the standpoint of developing programs to encourage more active conservation, these findings draw attention to two issues. The first has to do with getting people to recognize and believe in the existence of soil problems. Whether the scores on reported soil erosion differ so greatly between the conserver and probability groups because the differences are actual or only perceived needs to be dealt with within the framework of education, demonstration and training in the recognition and measurement of soil loss. It may indeed be the case that the conserver group has greater erosion potential on their farms. However, given that we know they have taken at least some steps to control it, and yet still believe it to be more severe, suggests on the other hand that most other farmers have trouble recognizing erosion problems when they exist. While training farmers to recognize erosion may amount to

a significant task for administrators, it must be understood that no action towards a problem can be expected until it can be seen, and by the time it becomes obvious it is often too late.

The second problem has to do with convincing people that their own farm practices contribute to soil losses independent of the physical terrain of the farm. Recognizing soil loss is one step. Ascribing some degree of personal responsibility for it is the necessary second step, if action to combat it by changing farming practices is going to be undertaken. The analysis suggests that farmers in the probability sample tend to deny their own contributions to soil problems more so than those in the conserver group. It can be seen that most farmers in the probability sample believe their terrain is flat (Table 4.9), and this, no doubt, is the basis for them being less convinced that soil loss due to erosion is occurring on their farms. If farmers believe site conditions alone are responsible for soil loss, and not their own farming practices, there can be little chance of changing tillage practices even when erosion can be pointed out.

The final set of comparisons in Table 4.11 is between two indices created for this analysis to represent summary soil erosion conditions and the potential for soil loss on individual farms. The first is a five-item, self-report scale on the severity of soil erosion on the farm. It is created by combining responses to the 2 questions concerning severity of interril and rill erosion, with the question on overall water erosion, and the two questions concerning the extent to which steep slopes and long slopes contribute to erosion. The interpretation of this scale is that it represents an index of <u>perceived</u> erosion on the farm. High

scores on the scale represent the respondent's perception that the farm has significant erosion problems. The scale ranges between 5 and 20, has an overall mean of 9.97 (s.d.= 3.61) and reliability (Chronbach's alpha) of .81.

The second scale is created to serve as a more objective indicator of erosion potential on the farm than is available from a scale of the respondent's perceptions of the severity of erosion problems. This index combines the rainfall factor (R) associated with the county in which the farm is located , with the soil erodibility factor (K) and slope-length factor (LS) from the Universal Soil Loss Equation. The scale represents the potential for soil loss on the farm based on physical conditions associated with location and climate, the soil type and the slope conditions on each farm. Multiplying this index across other factors representing crop management practices (C) and erosion control practices (P) provides the full Universal Soil Loss Equation and a prediction of soil tonnage per acre lost annually on the basis of the farm's terrain and locale, and the operator's farming practices. However, for now the scale, is left unadjusted for cropping or tillage practices, and serves as an index representing the potential for soil loss on the farm based on reported slope and soil conditions and the farm's location in the SWEEP project area.

The comparison of these two scales suggests again the higher erosion potential of the farms of the conserver group. In one case, however, the scale differences represent differences in the respondents' perceptions of the extent to which erosion already exists on their farms, and in the other case the differences suggest there to be either different physical conditions

associated with the farms of the two samples, or there are differences in the operators' abilities to recognize the soil and slope conditions of their farms. It could be said that the first scale represents what is the consequence of the insight provided by the second. In any case it seems that on both levels, farmers of the conserver group have a better understanding. Table 4.12 provides Pearson product moment correlations (r) between these scales and the other farm and operator factors previously identified as being important.

Table 4.12

Factors Relating to Reported Erosion Indices

Variable	Erosion Indices: 5 item scale r	5 item scale p	USL Scale r	USL Scale p
Sample	.28	.00	.15	.00
Farm Factors				
Acreage	.16	.00	.04	.27
Estimated value	.22	.00	.10	.05
1987 sales	.17	.00	.12	.03
1987 family income	.02	.40	.14	.01
1987 debt	.19	.00	.08	.09
Debt ratio	.04	.29	.02	.38
Sales ratio	-.01	.50	-.04	.27
Income ratio	-.04	.28	.05	.21
Farm future: to be sold	.02	.37	.03	.30
Operator Factors				
Age	-.10	.05	-.03	.33
Education	.24	.00	.10	.05
Number of years as operator	-.10	.05	-.02	.40
Number of years farm in family	-.01	.42	.01	.43
Partners	.03	.27	-.05	.18
Number in household	.10	.03	.04	.23
Children living at home	.13	.01	.02	.37
Off-farm employment	-.01	.48	-.01	.42
Between Indices (r)		.41		

4.2 Conservation Practices

In this section we examine the tillage and cropping practices used in 1987 for evidence of conservation forms of farming. The comparison is again between the conserver group and the probability sample, but now the answers to two questions are being sought. First, what are the behaviours of genuine adopters? Scrutiny of the conserver group's responses to the survey prior to the analysis provided convincing evidence that this group is actively committed to soil conservation. What then are the actual practices of such a group? Most importantly, how much conservation is practiced or, alternatively, how important still are conventional tillage practices on the farms of adopters?

Second, what are the behaviours of the general cash crop farming public? Now, nearly three years into the SWEEP program, and following a number of years of active promotion of soil conservation throughout North America, how are the farmers of south-western Ontario responding? Are there grounds for optimism, or are Ontario farmers falling short in their commitment to soil preservation?

Table 4.13 compares the reported 1987 primary tillage practices for the probability and conserver groups. The table provides some grounds for optimism concerning the future of soil conservation in Ontario. Although 86.5 of the farmers in the probability sample reported using conventional moldboard fall ploughing in 1987, a surprising proportion, 47.6 percent, also reported using reduced tillage on some or all of their fields. These methods include the use of a chisel plough, disc/coulter chisel, heavy disc harrow, or the use of the moldboard in

the spring. Almost one-third of the cropland in harvest for that year, 31.3 percent, was affected by these methods. While only 13 farms in the probability sample reported using more complete methods of conservation tillage, such as ridge tillage, no till or modified no till (and the proportion of affected cropland is less than 1 percent), it is nevertheless encouraging to see the proportion of the general farm public reporting making at least some attempts at soil conservation by less intensive tillage practices reaching almost 50 percent.

More than one-half of the conserver group, 51.9 percent, also employed conventional tillage on their farms in 1987, although only about thirty percent (30.4) of cropland was affected. Nearly sixty percent of the farms in the conserver sample used reduced tillage, with the percentage of affected cropland being approximately equal to that of the probability sample. Ridge tillage, no till or modified no till was used by between 22.2 percent and 31.5 percent of the conserver sample, with about 35 percent of the cropland of the conserver farms being affected.

Table 4.13

Tillage Practices - 1987

Tillage Practice	Probability Proportion[1] Used	Acres	Conserver Proportion[1] Used	Acres	Sig[3]
Conventional Tillage	.865 (217)[2]	.675	.519 (28)[2]	.304	.00
Reduced Tillage	.476 (120)	.313	.593 (32)	.346	.91
Ridge Tillage	.004 (1)	.004	.222 (12)	.180	.00
No Tillage	.028 (7)	.002	.278 (15)	.053	.00
Modified No Tillage	.020 (5)	.005	.315 (17)	.117	.00

[1]Proportions do not sum to 1 due to multiple practices
[2]Number reporting practice in subsample
[3]Difference between proportion of affected acreage

Table 4.14 provides further detail on the farming practices of the two samples during 1987. The moldboard plough was used on 49.7 percent of the fields of the farms in the probability sample, and 26.6 percent of fields in the conserver sample. The next most common primary tillage instrument among the probability sample was the cultivator (19.8 percent), followed by the tandem disc and harrows (8.8 percent of fields), Disc/coulter chisel plough (6.9 percent), and chisel plough (5.4 percent). No till farming was used on only

slightly more that 1 percent of fields in the probability sample, and the use of the modified moldboard was employed on less than one percent of fields.

Alternatively, no till farming was the second most common primary tillage practice for the conserver group, being used on 23.1 percent of fields. The conserver group also used the modified moldboard on significantly more fields in comparison to the probability sample, although the proportion of affected fields is quite small. Except for these practices there are no other statistically significant differences for the types of primary tillage used by the two samples.

For seedbed preparation the conserver sample used the field cultivator on fewer fields in comparison to the probability sample, although for both groups this is still the most commonly used implement. The cultipacker was also used on proportionately fewer fields by the conserver group, and no till was practiced on 25.2 percent of the conserver's fields, whereas this was the case on less than one percent of the fields of the probability sample. Finally, the probability sample usually used either a regular planter or seed drill during planting (68.2 percent of fields affected), while the conserver group was more divided with about 40 percent of the fields being planted using either a modified planter or seed drill, and about 35 percent being planted with with a regular planter or drill.

Table 4.14

Farming Practices 1987 by Proportion of Affected Fields

Farming Practice	Sample Probability Prop.[1]	N	Conserver Prop.	N	prob.
Primary Tillage					
Moldboard plough	.497	240	.266	55	.00
Modified moldboard	.004	256	.035	55	.02
Chisel plough	.054	255	.068	55	.60
Disc/coulter chisel	.069	254	.110	55	.16
Tandem disc/harrows	.088	249	.057	55	.24
Cultivator	.198	243	.155	55	.19
No primary tillage	.013	256	.231	55	.00
Seed Bed Preparation					
Field cultivator	.449	238	.313	51	.02
Spring tooth cultivator	.153	252	.083	55	.11
Disc and harrows	.175	243	.125	53	.26
Drag harrows	.049	253	.046	55	.91
Cultipacker/rollers	.168	252	.074	55	.03
Mulch tiller	.028	257	.059	54	.45
No tillage	.005	259	.252	54	.00
Seeding					
Regular planter	.476	218	.222	50	.00
Regular seed drill	.206	227	.135	52	.05
Modified planter	.024	253	.332	49	.00
Modified seed drill	.003	257	.073	53	.00
Broadcast planter	.007	256	.007	54	.95
Transplanter	.005	255	.000	54	.25

[1]Proportion of fields on which implement used

Direction of travel on slopes during tilling and planting is given in Table 4.15. The probability sample reports travelling across slope on 44.4 percent of fields having a hill or slope. This is followed by tilling up and down the slope (33.3 percent of fields) and by tilling in a direction unrelated to slope (18.2 percent). The most common practice by the conserver group is to till in a direction unrelated to slope (36.1 percent), followed by across slope and then up and down tillage. Only about 3 percent of hilly or sloping fields are tilled on the contour. There are no significant differences in the practices of the two groups for the direction of travel, with the most common practice being up and down slope planting, followed by across slope planting.

Table 4.15
Direction Travelled During Tilling and Planting

Direction of Slopes	Sample Probability Prop.[1]	N	Conserver Prop.	N	prob.
Tillage					
Up and down slope	.333	186	.209	49	.07
Across slope	.444	187	.262	46	.02
On the contour	.030	187	.028	49	.92
Direction unrelated	.182	182	.361	46	.00
Planting					
Up and down slope	307	177	.258	49	.48
Across slope	.237	181	.178	50	.34
On the contour	.039	188	.042	49	.93
Direction unrelated	020	189	.001	50	.43

[1]Proportion of fields

Table 4.16 provides Pearson correlation coefficients between the various primary tillage, seedbed preparation, seeding, and direction of travel practices for the type of sample and the two variables developed earlier to represent erodibility on the farm: 1) the five item perceived erosion scale and 2) the index representing physical conditions of the farm in relation to weights assigned by the Universal Soil Loss Equation. These correlations provide evidence of the strength and direction of association between farming practices, the sample and erosion conditions on the farm, real or perceived. To allow easier interpretation, only those associations reaching the conventional .05 significance level (one tailed) are being reported.

Given the significance criterion, it is evident from the number of correlations being reported that there are not a large number of associations between these farming practices and the estimates of erosion conditions on the farm. Nevertheless, where they are significant, most of the correlations are in the anticipated direction. Thus, being in the conserver group, or perceiving erosion to be a problem on the farm, leads to positive associations with conservation forms of farming and negative associations with conventional farming practices. For example, no primary tillage correlates positively .48 with being in the conserver group, as well as .18 with scores on the perceived erosion index, while use of the conventional moldboard plough correlates negatively with being in the conserver group, as well as with the erosion index. In general there are more significant correlations, and the levels of associations are stronger (positive or negative) with respect to associations between farming practices and the sample, than is the case between practices and the erosion indices. Given the makeup of

the conserver group this is not surprising, and while farm practices do not correlate as highly with the erosion indices as they do with the respondent's sample, there is still evidence here that, whether erosion is perceived or otherwise estimated on the basis of physical factors of the farm, such scores are still useful to the prediction of farming practices.

Table 4.16
Correlations of Farming Practices With Sample and Erosion Indices

	Correlation with					
	Sample		Erosion Index		USL Index	
% Fields	r	sig	r	sig	r	sig
Primary Tillage						
Moldboard plough	-.27	.00	-.10	.05		
Modified moldboard	.13	.01			.17	.00
Chisel plough						
Disc/coulter chisel						
Tandem disc harrows						
Cultivator						
No primary tillage	.48	.00	.18	.00		
Seedbed Preparation						
Field cultivator	-.13	.01				
Spring tooth cultivator	-.13	.01				
Disc and harrows				.12	.02	
Drag harrows						
Cultipacker	-.13	.02				
Mulch tiller						
No tillage	.52	.00	.16	.00		
Seeding						
Regular planter	-.30	.00	-.19	.00	-.14	.01
Regular seed drill	-.12	.03				
Modified planter	.49	.00	.19	.00	.15	.01
Modified seed drill	.28	.00	.17	.00		
Broadcast planter						
Transplanter						
Direction						
Till up/down	-.12	.04	-.18	.00	-.13	.03
Till across	-.16	.01	.13	.02		
Till on contour						
Till unrelated	.19	.00			.11	.05
Plant up/down						
Plant across		.22	.01			
Plant on contour						
Plant round & round						
Plant unrelated	.12	.04	.14	.02		

Table 4.17 gives frequencies for the combined conserver and probability samples on three variables used to measure levels of conservation by the analysis group. The first variable, reported tillage practice for 1987, groups the sample according to three levels of conservation tillage: 1. None -- conventional moldboard fall tillage only; 2. combination -- conventional moldboard tillage along with reduced till or no till on some fields; 3. conservation tillage only: no conventional moldboard tillage. As can be seen, of the 303 farms reporting, 36.3 percent reported some conservation tillage was used on the farm in 1987, and 58 farms, or 19.1 percent of the combined sample report using only conservation tillage. Altogether, 55.4 percent of farms report using conservation till in 1987, at least to some extent.

The second variable in Table 4.17 reports whether any significant crop residue was left on fields following planting in 1987. Normally crop residues in the range of 20 to 30 percent are seen to be consistent with soil conservation objectives, and while not all farmers who claimed to leave significant crop residue estimate levels as high as 20 percent (overall 44.5 percent of field were reported to have crop residues in excess of 20 percent) it is, nevertheless a positive sign when farmers report leaving any significant crop residue. In the case of this combined sample, 57.7 percent of the 310 farms reporting indicated that significant crop residues were left on fields.

Finally, the third factor contained in Table 4.17 is the reported percentage of cropland on which conservation tillage was used in 1987. Of 300 farms reporting, 134 claimed no such

tillage was used, but 58 farms reported that conservation tillage was used on 100 percent of the farm's cropland acreage in 1987. Overall, over one-third (35.8%) of all cropland farmed by this sample in 1987 employed conservation tillage.

Table 4.17

Reported Conservation Tillage

Variable	N	%
Reported Tillage Practice - 1987		
Conventional tillage only	135	44.6
Conv. tillage and cons.	110	36.3
Conservation tillage only	58	19.1
	303	100.0
Significant Crop Residue		
No significant residue	131	42.3
Yes significant residue	179	57.7
	310	100.0
% Acreage Cons. Till		
Zero	134	44.7
1-25	24	8.0
26-50	44	14.7
51-75	24	8.0
76-99	16	5.3
100%	58	19.3
	300	100.0
Mean	35.8	
S.D.	40.4	

Table 4.17 suggests quite high levels of conservation tillage used in 1987 and significant levels of crop residue being left on fields. For the most part there is greater commitment to conservation here than is normally anticipated for Ontario farmers. Much of the reason for these high levels of involvement in this case is, of course, due to the conserver sample, which was selected with the deliberate intent of over representing conservation farming and is, without question, inflating the estimates in Table 4.17. However, even breaking these participation rates down by sample type, does not lead to the conclusion that Ontario cash crop farmers are not involved in conservation. Tables 4.18 and 4.19 examine tillage practices and the leaving of significant residue on fields by sample type. In Table 4.18 it can be seen that most of the conserver sample (87%) practiced conservation tillage on all or part of their farm in 1987. Nevertheless, almost one-half (48.6%) of the probability sample also practiced conservation tillage to some degree in 1987, and in the case of 32 of the farms reporting (12.9%), that is all they did. Similarly, in Table 4.19 proportionately more of the conserver group report leaving significant crop residue in comparison to the probability sample (83.6% vs. 52.2%), but significant crop residue is still reported by a majority of farmers in the probability sample.

Table 4.18

Conservation Tillage by Sample - 1987

Practice	Sample Probability %	N	Conserver %	N	Total %	N
Conventional tillage	51.4	128	13.0	7	44.6	135
Conventional and conservation	35.7	89	38.9	21	36.3	110
Conservation only	12.9	32	48.1	26	19.1	58
Total	100.0	249	100.0	54[1]	100.0	303
Chi-Square		27.59				
prob.		.00				

[1] - 1 farm in conserver group used conservation tillage, but could not be classified.

Table 4.19

Reported Residue by Sample

Self-Report:	Sample Probability	Conserver	
Is significant residue left on fields?			
Yes	52.2% (133)	83.6% (46)	$X^2_1 = 18.38$ Sig.= .00
No	47.8% (122)	16.4% (9)	Phi = .24
Proportion affected:			
Fields over 20%	38.8[1]% (129)	60.5% (46)	$t_{173} = -3.09$ Sig. = .00
Acreage over 20%	38.7% (127)	61.6% (45)	$t_{170} = -3.19$ Sig. = .00

[1] Percentage area affected by group reporting that significant residue is left on fields

The final comparisons for farming practices in 1987 examine the associations between important farm, operator and erosion factors and the scale of involvement in conservation tillage for 1987 just reported on, after it has been collapsed to a dichotomous scale of non-adoption/adoption of conservation tillage for this growing season. This scale is one way of identifying conservers, other than through the conserver sample, and it is useful to examine what socio-demographic characteristics of the operator, financial and other structural aspects of the farm, and erosion conditions on the farm are related to practicing conservation. However, for now our interest is not in the non-probability sample of known conservers, but in seeing what is associated with being a conserver in the general cash crop farming public. That is, are different factors related to conservation in the general farming public, than those associated with being in the selected conserver group (Tables 4.1 to 4.11)?

Table 4.20

Factors Associated with Conservation Tillage for the Probability Sample

Factor	1987 Tillage Practice[1] r	prob.
Erosion Indices		
Reported erosion	.15	.01
USL potential scale	.11	.04
Farm Factors		
Acreage	.05	.21
Estimated value	.16	.01
1987 sales	.09	.09
1987 family income	-.11	.05
1987 debt	.05	.25
Debt ratio	-.10	.09
Sales ratio	-.08	.12
Income ratio-.11		.05
Farm future: to be sold	-.12	.03
Operator Factors		
Age	-.10	.09
Education	.12	.04
Years as operator	-.10	.07
Years as family farm	-.04	.28
Partners	.16	.01
Number in household	.04	.27
Children living at home	.02	.36
Off-farm employment	.01	.43

[1]Dichotomous adopter/non adopter variable

Table 4.20 reports point biserial correlations between selected erosion, farm and operator factors and the dichotomous variable of conservation non-adoption/adoption during 1987. Adopters among this sample tend to perceive erosion on their farms to be high (r=.15, p.=.01), as well as to have higher scores on the Universal Soil Loss potential scale discussed earlier (r=.10, p.=.04). However, adopters do not appear to have larger farms, as was the case with the conservation sample (r=.05, p=.21), although their farms to do tend to have higher value (r=.16, p=.01). Adopters also tend to have less income on average (r=-.10, p=.05), in addition to earning less return on investment from the farm operation (r=-.11, p=.05). The future plans for the farm are that it remain in the family (r=-.12, p=.03). Adopters also tend to be younger (the correlation falls just slightly short of conventional significance, r=-.10, p=.09), and to be better educated (r=.12, p=.04), as well as to be in partnership with another, not their spouse (r=.16, p=.01). Other factors of the farm and the operator tend to be unrelated to adoption. Finally, while these associations are similar to those reported elsewhere in the literature, as well as to approximate closely the profile of the conservation sample reported on earlier (with two exceptions), they are, while statistically significant, still not large. Thus it seems there are a number of factors common to conservation tillage adopters in south-western Ontario, although it cannot be said, given the magnitudes of the associations, that on the basis of these such farmers are easily identified.

4.3 Attitudes

Environmental attitudes can be important pre-determinants to conservation behaviour. While in the soil conservation field most interest has been paid to factors involving the financial incentives for conservation, there is significant doubt that conservation will ever be seen by the majority of farmers to be financially attractive. Indeed it is safe to say that programs to encourage conservation -- in farming as well as in areas of other kinds of societal environmental concern -- have attempted too often to stress the financial benefits of such practices, when these were either far from certain, or at best, slow to materialize, and hard to recognize. Alternatively, attempts to make conservation financially viable through government programs involving low cost loans and subsidies (e.g., the current Land Stewardship program in Ontario) may be similarly misdirected. While such approaches may encourage some farmers to adopt conservation tillage, they may also imply that the sole basis for deciding to practice conservation rests on its financial merits, while at the same time suggesting that the government will accept responsibility for ensuring that conservation is financially attractive.

What this ignores, in fact subverts, is an approach to conservation which involves an individual's long-term willingness to prevent soil loss through conservation which is based on an ethical and moral commitment to the land, and which is practiced in spite of the extra effort and financial sacrifices which may be involved. In the words of the well known American naturalist, Aldo Leopold, who, over forty years ago, similarly argued against conservation promotion being made mainly on the grounds of its questionable economic merits, or

government assistance, "In our attempt to make conservation easy, we have made it trivial" (Leopold, 1949 [1966]: 246). Current approaches to soil conservation in Ontario may fail if we ignore, or do not emphasize strongly, that the primary reason for practicing conservation is not to make money, but to protect the land.

Nevertheless, it would be foolish to suggest that the financial aspects of conservation can be prevented (or should be prevented) from playing an important part in the farmer's decision to adopt or not adopt conservation tillage. What needs to be recognized is that there are important non-monetary considerations which also influence the farmer's decision. To the extent that attitudes, beliefs and values can be linked to the practice of conservation, they exist as alternative aspects of influence to which programs promoting conservation could be directed. A second reason for studying attitudes is to estimate their relative importance in relation to economic factors in the context of the farmer's decision to adopt conservation tillage. It would be easy to conclude that the adopters of our sample have, for the most part, arrived at the decision to practice conservation because they are convinced of its financial soundness. However, it may be that conservers find that conservation tillage is, all and all, financially unattractive, and it is for other reasons they have decided to adopt it.

Table 4.21 presents responses to the farm practices survey on a number of summary attitude, belief and moral commitment factors relating to soil loss and conservation in Ontario. These are summative scales, for the most part, found from factor analysis to have reasonably stable inter-item reliabilities (Chronbach's alpha) with respect to a latent belief or attitude

construct concerning soil problems and conservation practices. Table 4.21 reports the mean for each scale, together with its minimum and maximum, sample size and coefficient of relative variation (CRV). The CRV is calculated by dividing the scale's standard deviation by its mean, and allows the relative variability in responses to be represented, while taking into account the greater variability which usually occurs when scales are comprised of more items and have higher means. The individual items from the survey used to make these scales are described in Appendix B.

Table 4.21
Attitude and Belief Scales

Scale	Descriptive Statistics Mean	CRV	Min	Max	N
Beliefs					
Soil loss	14.55	.20	6.0	20.0	283
5 items, á = .74					
Land is economic commodity	7.31	.29	3.0	12.0	291
3 items, á = .70					
Gov. responsible for solution	6.80	.33	3.0	12.0	294
3 item, á = .69					
Others can solve problem	4.20	.37	3.0	12.0	292
3 item, á = .68					
Innovator	5.05	.29	2.0	8.0	295
2 item, á = .66					
Awareness of consequences	2.44	.41	1.0	4.0	296
1 item					
Land Stewardship					
Obligation to protect land	2.93	.29	1.0	4.0	301
1 item					
Survival as farmer comes first	2.69	.36	1.0	4.0	295
1 item					
Attitudes Toward Conservation					
Cons. till is poor business	9.91	.28	4.0	16.0	289
4 item, á = .75					
Benefits outweigh shortcomings	5.54	.31	2.0	8.0	282
2 item, á = .80					
Moral obligation	4.32	.23	1.0	5.0	305
1 item					
Commitment	4.09	.23	1.0	5.0	306
1 item					
Importance	4.25	.17	1.0	5.0	305
1 item					
Commitment scale	12.66	.17	5.0	15.0	297
3 item, á = .71					
Behavioural Intention Scale, 2 item	2.95	.63	1.0	5.0	302

The first six variables contained in Table 4.21 represent several distinct beliefs held by operators concerning the existence of soil problems and what should be done about them. The first scale, soil loss, measures the belief that soil loss due to erosion is a serious problem in Ontario. The scale is made up of five variables of four alternative responses each (definitely agree to definitely disagree) and has a mean of 14.55, with minimum of 6 and maximum of 20. High scores on this scale represent the belief that soil loss due to erosion is occurring and is a serious problem in Ontario. The mean on this scale, equalling almost 15, suggests that respondents to this survey are, on average, inclined to believe in that soil loss due to erosion is a problem in Ontario. The coefficient of relative variation, 20, suggests reasonable homogeneity, or agreement, on this question, although there is some disagreement as well, and the minimum of 6 represents at least one person who denies almost completely that any significant soil loss is occurring in Ontario.

The remaining five belief factors in Table 4.21 represent in turn: a) a three item scale on the belief that land is mainly an economic factor to be used as input into business (mean=7.31, min.=3, max.=12); b) two three item scales each representing different sources of responsibility for helping to solve soil loss problems in Ontario. In one case the solution to such problems is being shifted to the government (mean=6.80, min.=3, max.=12), and in the second case it is being shifted to other farmers (mean=4.20, min.=3, max=12); c) a two item scale representing the operator's own self-definition, or self-belief, with respect to whether they are an innovator, or risk taker, in deciding about new farming technology (mean=5.05, min.=2, max.=8), and d) a one item scale on the extent to which the operator agrees that soil

loss will eventually hurt his farm. This final variable is an indication of the farmer's awareness of the consequences for failing to prevent soil loss on his own farm (mean 2.44, min. 1, max. 4).

The two variables under Land Stewardship in Table 4.21 are each one item scales representing alternative long-term approaches to the land. The first factor (mean=2.93, min.=1, max=4.) represents agreement to the question that the operator's chief obligation is to protect the land, at all costs. The second factor (mean=2.69, min.=1, max=4) represents agreement to the question that the operator's survival as a farmer comes first, even if the land must wait. Both questions received relatively high degrees of overall support among the survey respondents. Further, while they are negatively correlated (-.21, $p.<.01$), the size of this relationship is not large, suggesting that farmers, on the whole, do not see these two approaches to the land as being mutually contradictory.

The next six variables in Table 4.21 all represent specific attitudes on conservation farming practices. The first variable is a four item scale representing agreement that conservation tillage is an unprofitable business practice. The mean on this scale, 9.91, and the median, 10, indicate that the sample is nearly equally divided with regard to whether conservation tillage is seen to be financially worthwhile. The second scale represents the respondents' attitudes toward conservation tillage over the long term. This two item scale suggests that the majority of farmers, whether they practice conservation tillage or not, feel that its benefits will eventually outweigh its shortcomings. However, again the overall mean,

5.54, is close to the midpoint for the scale suggesting that many farmers do not agree with this view. The remaining scales all represent some aspect of deep commitment toward soil conservation. Many of the respondents to the survey report feeling a moral obligation to practice conservation (mean=4.32), as well as stating that they are committed to soil preservation (mean=4.25), and feeling that soil conservation on their farm is somewhat or very important (mean=4.25). These three factors imply potentially high levels of moral commitment to prevent soil loss among farmers, and they have been combined into a single index representing an overall scale of willingness to practice conservation (mean=12.66, alpha=.71).

The final variable reported in Table 4.21 is a measure of the farm operator's behavioural intention to practice conservation tillage. It is created by combining responses on reported farming practices for respondents in the sample who actually used conservation tillage in 1987 with those who did not, but who report intending to use it soon, and those who say they will not use it. Such a variable is probably highly indicative of levels of actual approval for conservation tillage in the sample, and is very close to actual behaviour. The scale of 2.95 and median of 3 suggest an almost even split between respondents to this survey reporting they do not intend to practice conservation tillage, and those who did practice conservation tillage in 1987 or say they intend to begin soon.

In Table 4.22 comparisons between the conserver and probability sample are again being made, this time on the attitudinal variables just described. There are significant

differences between the probability and conserver groups in the case of every variable, excepting one, and in each instance the differences are in the direction favouring greater conservation by the conserver sample. Thus, the conserver group is significantly more likely to believe in the existence of soil problems (t=-5.63, p.<.01), and less likely to feel that land is simply an economic input (t=2.73, p.<.01). This group is also more likely to deny that solutions for soil problems should rest with the government or other farmers (t=2.15, p.=.02; t=2.90, p.<.01), while being more likely to see themselves as innovators in terms of farming practices (t=-8.00, p.<.01) and to feel there will be deleterious long term consequences if soil loss is not arrested on their farm (t=-2.97, p.<.01).

One unanticipated outcome with respect to the findings reported here is that the probability sample reports significantly higher levels of obligation to protect the land, compared to the conserver group (t=1.80, p.=.04). However, this is offset by the greater tendency of the conserver group to deny that their own survival as a farmer should come before all else (t=2.32, p.=.02), while also denying that conservation tillage is a poor business practice (t=6.82, p.<.01). The conserver group reports being significantly more committed to soil conservation on grounds of feeling a moral obligation to prevent it (t=1.58, p.=.06), being committed to soil preservation (t=-5.37, p.<.00) and feeling it is important (t=-2.60, p.<01). Finally, the conserver group reports feeling significantly more committed to conservation in terms of the three item commitment scale (t=-3.97, p.<.01), as well as being significantly higher on behavioural intention (t=-6.74, p.<01).

Overall, Table 4.22 suggests two things. First, it appears that attitudes and beliefs usefully predict conservation behaviour. It has often been claimed that attitudes are unrelated to behaviour -- that what people feel is unrelated to what they do (Deutscher, 1966; Wicker, 1969). Any careful review of the general literature on attitudes and behaviours, however, suggests strongly that attitudes are reasonable predictors of behaviours, given the right conditions (Rajecki, 1982). Such a general conclusion has been replicated with respect to a number of specific conservation behaviours (Heberlein and Black, 1976; Weigel and Newman, 1976; Bowman and Fishbein, 1978; Heberlein and Warriner, 1983). Further, what is important to note from a policy or regulatory perspective is that no single attitude is normally sufficient to predict a behavioural outcome. Rather it is the constellation of beliefs and attitudes, tending towards internal consistency and mutual reinforcement, that allows the linkage to behaviour to be made. This appears to be the case for conservers and non-conservers in this survey, as suggested by Table 4.22. The conserver sample maintains a set of attitudes and beliefs which is consistent with the behaviours of the their large majority, which is to practice conservation. They believe in the existence of soil erosion problems in Ontario, and in their own responsibility to prevent it, while accepting a moral obligation to reducing soil loss on their farms, and denying that conservation is a bad business practice.

The lesser incidence of conservation by the probability sample is also explained. Their less active levels of conservation do not stem from a single belief, but again are a function of the set of generally more negative beliefs and attitudes they hold with respect to the financial benefits of conservation, the belief in the seriousness of soil loss and who is responsible for

solving it, and of themselves as innovative farmers with a moral commitment to conserve soil. If programs to encourage conservation are to be successful, they should be directed towards sets of factors found to be influencing behaviours such as these. Information campaigns which are directed at a single attitudinal object or belief (existence of soil loss, social responsibility, financial benefits, etc.) are unlikely to change behaviours, even if they are successful in changing a particular attitude or belief.

Second, while it is the case that the conserver group differs from the probability sample on these attitudinal and belief variables, there is still evidence of a willingness among the probability sample to practice conservation. While the conserver group is significantly higher (or lower as the case may be) on these attitudinal and belief variables, in the majority of cases the probability sample is still above (or below) the midpoint on the scale in the direction of being inclined towards conservation. The average operator in the probability sample still believes that soil loss is occurring in Ontario, and accepts personal responsibility for overcoming it. However, he is less inclined to define himself as an innovator in farming practice, and is less aware of the long term consequences of soil loss on his farm. He also tends to believe his own survival as a farmer must take precedence over the land, and to feel that conservation tillage is an uneconomical business practice. Aside from these differences, however, the farmers of the probability sample tend to hold many similar attitudes and beliefs as those in the conserver group. Hence, while they are not as active conservers as the farmers in the conserver sample at this time, it cannot be said they are opposed to conservation, or that they are far away from becoming conservers themselves.

Table 4.22

Differences in Beliefs and Attitudes Between Probability and Conserver Samples

Cognitive Factor	Sample Probability mean	s.d.	Conserver mean	s.d.	t	prob.[1]
Beliefs						
Belief in soil loss problems	14.15	2.64	16.44	3.17	-5.63	.00
Land is economic commodity	7.45	2.03	6.61	2.25	2.73	.00
Gov. is respons. for solutions	6.92	2.19	6.23	2.17	2.15	.03
Others can be responsible	4.30	1.61	3.64	1.23	2.90	.00
Innovator	4.78	1.33	6.33	1.23	-8.00	.00
AC: Need to stop soil loss on this farm	2.36	.98	2.81	1.06	-2.97	.00
Land Stewardship						
Obligated to protect land	2.97	0.80	2.75	0.93	1.80	.04
Survival as farmer comes first	2.75	0.94	2.42	1.08	2.32	.02
Attitudes Toward Soil Conservation						
Conservation till is poor business	10.37	2.46	7.76	3.08	6.82	.00
Benefits outweigh shortcomings	5.20	1.61	7.14	1.23	-8.41	.00
Moral obligation	4.28	0.98	4.51	1.03	-1.58	.06
Commitment to soil conserv.	3.97	0.94	4.67	0.58	-5.37	.00
Importance of soil conserv.	4.20	0.72	4.48	0.63	-2.60	.00
Commitment scale	12.45	2.13	13.66	1.61	-3.97	.00
Behavioural Intention Scale	2.63	1.82	4.38	1.33	-6.74	.00

[1]1-tailed

Table 4.23 provides evidence of the relationships between the various factors on beliefs about soil loss, and on conservation being a poor business practice, the moral commitment scale and behavioural intention and the other attitude and belief variables. These findings provide further evidence of how the internal consistency existing between attitudes and beliefs serves to reinforce other attitudes and beliefs and influence the likelihood of the farmer adopting conservation tillage. It also serves to explain, at least in part, why certain farmers tend to believe that conservation is poor business while others are committed to conservation and intend to practice it. Thus farmers who believe in the land as being a mainly economic factor in their farming enterprise, tend also to deny the existence of soil problems in Ontario, while agreeing that conservation is poor business, and feeling less committed to soil preservation, with less intention to practice conservation.

A similar pattern of relations holds for farmers who feel that the government and other farmers should be responsible for solving erosion problems, and for those that feel their survival as a farmer comes first, even at the expense of the land. In addition, farmers who feel conservation is poor business, tend also not to regard themselves as innovators; to feel that in the long run the benefits of conservation will not outweigh its shortcomings; to deny that in the long run erosion will harm their farm; and to be less committed to conservation, with less intention of practicing it.

On the other hand, farmers who have a moral commitment to conserve tend to feel the opposite. These farmers tend to deny that their land is mainly an economic commodity, and that the government or other farmers are responsible for solving soil problems, or that their survival as a farmer comes before all else, or that conservation is poor business. Rather they see themselves as innovators, with an obligation to protect the land, while feeling that the benefits of conservation will eventually outweigh its shortcomings. They also tend to be aware of the consequences of soil loss on their own farms, to believe in the existence of soil erosion problems, to be committed to conservation, and to intend to practice it.

Table 4.23

Correlations Between Attitudes and Beliefs

Cognitive Factor	Correlation with ..... Beliefs in Soil Loss		Cons. is Poor Business		Commitment Scale		Behavioural Intent.	
	r	sig	r	sig	r	sig	r	sig
Land is economic commodity	-.43	.00	.36	.00	-.28	.00	-.13	.01
Government is responsible	-.14	.01	.27	.00	-.16	.00	-.13	.01
Others can be responsible	-.31	.00	.29	.00	-.46	.00	-.26	.00
Innovator	.28	.00	-.34	.00	.31	.00	.37	.00
Obligation to protect land	.01	.40	-.03	.29	.16	.00	-.07	.13
Survival comes first	-.18	.00	.25	.00	-.25	.00	-.06	.17
Benefits outweigh shortcomings	.49	.00	-.56	.00	.36	.00	.49	.00
Awareness of consequences	.33	.00	-.24	.00	.24	.00	.24	.00
Beliefs in soil losses	-	-	-.43	.00	.34	.00	.31	.00
Cons. is poor business	-.43	.00	-	-	.37	.00	-.40	.00
Commitment scale	.34	.00	-.37	.00	-	-	.35	.00
Behavioural intention	.31	.00	-.40	.00	.35	.00	-	-

Table 4.24 provides a summary appraisal of the influence of the various attitude and belief factors, including attitudes on the economics of conservation, along with the erosion indices, the characteristics of the farm and socio-demographic factors of the operator in relation to conservation practices and behavioural intention. The variables contained in this table allow the influences of the various attitudinal, economic, geographical and socio-demographic characteristics of the farm and farm operator to be compared with respect to their relative impacts on actual conservation or the intention to conserve. The tillage practice variable on which comparisons are being made in this table is the dichotomous variable earlier developed from the operator's report of whether any type of conservation tillage was practiced on the farm in 1987. The behavioural intention scale combines reports of actual conservation tillage practices with reported intentions to practice conservation tillage in the near future.

In general, Table 4.24 provides qualified support for the suggestion that all dimensions of the farming operation -- cognitive, economic, geographic and socio-demographic -- are important in some degree in leading to the likelihood of the adoption of conservation tillage. According to the table the majority of the attitudinal and belief factors are related to behavioural intention, as was just discussed, in addition to being also predictive of the likelihood of having used conservation tillage in 1987. Farmers who feel that conservation tillage is a bad idea from an economic perspective are those who are least likely to try conservation tillage, while those who believe in the long term benefits of conservation are those who are most likely to practice it, or want to. It is also the case that the geographical conditions of the farm relating to soil and slope conditions, and the perceived existence of

erosion problems on the farm, are positively related to the practice of conservation and behavioural intention. Apparently farmers who think they have an erosion problem, or are able to see the potential for soil loss on their farms from their soil and slope conditions, are also more likely to practice conservation. As well, conservation is practiced on larger, more valuable farms, with more sales and more debts. However, factors of gross farm income, net family income, ratios of sales, debt and income to farm value, or the intention to sell the farm in the future are all unrelated to either conservation tillage in 1987 or behavioural intention. Finally, older farmers have less intention to practice conservation tillage in the future, but age is unrelated to conservation practices in 1987. Better educated farmers and those who are in business with another, not their spouse, are also more likely to have either used conservation tillage in 1987, or intend to use it.

Table 4.24
Factors Relating to 1987 Tillage Practice and Behavioural Intention

Factor	1987 Tillage Practice			Behavioural Intention		
	r	sig	N	r	sig	N
Attitudes and Beliefs						
Soil loss problems	.27	.00	303	.31	.00	302
Land as commodity	-.10	.05	303	-.13	.01	302
Gov. responsibility	-.06	.15	303	-.13	.01	302
Others responsible	-.19	.01	303	-.26	.00	302
Innovator	.34	.00	303	.37	.00	302
Survival comes first	-.10	.05	303	-.06	.17	302
Cons. is poor business	-.32	.00	303	-.40	.00	302
Benefits outweigh	.47	.00	303	.49	.00	302
Commitment scale	.22	.00	303	.35	.00	302
Awareness of consequence	.23	.00	303	.24	.00	302
Erosion Indices						
Reported erosion	.17	.00	303	.27	.00	302
USL potential	.10	.04	294	.14	.01	293
Farm Factors						
Acreage	.10	.04	302	.17	.00	301
Estimated value	.20	.00	289	.20	.00	290
1987 sales	.22	.00	281	.20	.00	280
1987 income	-.07	.13	245	.09	.09	245
1987 debt	.15	.01	270	.13	.02	272
Debt ratio	-.02	.37	270	-.02	.38	272
Sales ratio	-.02	.38	275	.03	.31	276
Income ratio	-.16	.01	242	.00	.49	243
Farm future: to be sold	-.05	.22	297	-.05	.19	296
Operator Factors						
Age	-.04	.26	288	-.11	.04	286
Education	.15	.00	296	.21	.00	296
Years as operator	-.08	.09	270	-.12	.03	267
Years as family farm	-.01	.46	253	-.01	.46	250
Partners	.17	.00	303	.09	.05	302
Number in household	.04	.27	297	.08	.07	296
Children living at home	.07	.13	303	.07	.13	302
Off farm employment	.00	.50	217	-.05	.23	220
Scale means	.75			2.95		
s.d.	.76			1.57		
r between indices		.54				

4.4 The Social Network

The notion of the social network in the context of adoption of conservation tillage adds a further dimension of understanding to the problem of how the decision to adopt conservation tillage is made. The four main elements of a diffusion event are: 1) an innovation, an idea perceived as new by the potential adopting unit; 2) which is communicated through channels, 3) over time, 4) among members of a social system (Rogers, 1979: 138). Basically the idea that the social network may be important with respect to the farmer's decision to adopt or to not adopt conservation tillage is straightforward. Since before any change in farming practice can be expected, the farmer must first receive information about the practice, and it is through his social network that this new information will be channelled.

Certain aspects of the network may facilitate more effective communication. For example, the farmer's location within a sphere of acquaintanceship may either facilitate or inhibit the effective transfer of information. Those who are isolates within this structure, or who have been unable to establish effective two-way transmission with other parties, may be at a disadvantage with respect to both acquiring information on new technology and in having a ready source of counsel on its implementation and practice.

The size of the network and its density may also affect the effectiveness of information transfer. The number of potential reciprocal communication channels increases geometrically with network size; there are 6 potential linkages in a network of 3, 12 in a network of 4, 20 with 5, 30 with 6, 42 with 7 etc. This means that larger networks provide not only more

sources of information to the farmer, but also increase the opportunities (channels) through which it may be received. At the same time, the density of the network, or the proportion of potential to actual connections among members, may act to both facilitate and impede the flow of information. Dense networks, in consideration of network size, provide greater opportunities for information transfer between members, since there are more communication paths. On the other hand, dense networks may also be more "closed" than those which are less dense, to the extent that their tightly interlocking nature can prevent entry of novel or innovative ideas.

Networks may also be related to diffusion of innovation as a function of the 1) knowledge characteristics of the membership, 2) their statuses, and 3) the members' relationship to the farmer. The network member's occupation may represent important sources of knowledge concerning developments in farming and how they may be implemented. For example, being a soil advisor, extension official or other farmer who has already tried conservation tillage should have more positive influence on the farmer's feeling toward conservation tillage than a family member or neighbor who does not practice conservation. In addition, the status of each network member provides a motivational basis for the farmer's receptiveness with respect to the information imparted. Finally, when dealing with innovative, or risky, new farming technology there is likelihood that individuals with whom the farmers has a "weak" link will serve as a better source of information than those with whom the link is "strong". The rationale behind this proposition centers on the understanding that each farmer's network may be differentiated according to both 1) degree of homophily (similarity) between

members of the network, and 2) level of attraction (strength of tie) between members. Thus homophily and close attraction facilitate effective communication, but may also act as barriers to prevent new ideas from entering the system. Alternatively, heterogeneity within networks and weak ties give the system more openness, enabling communications on farming innovations to flow more freely.

The survey on Ontario farm practices provides several opportunities to examine these network propositions, and to do so on two levels. In the first place there is the question of the degree to which farmers in the survey feel the need to utilize information in the network as a basis for making decisions about farming practices and conservation. Thus there are important normative aspects of behaviour that should be addressed. To what extent do farmers sense that their friends and neighbors feel they should practice conservation, and how important is such peer pressure when the farmer is deciding on what tillage practice to use? While the network membership may condone certain forms of behaviour, it is going to have little effect if the farmer is not motivated to comply with it.

In addition there are questions of who constitutes the network, and the network's size, character and relation to specific farming practices. For all these questions the individual farmer among those responding to the farm practices survey remains the unit of analysis (N=314), while the structural and motivational aspects of the networks for this set of individuals are examined. In addition, however, the individuals named in the network as being linked to the respondent may constitute the unit of analysis and the character of these relations

investigated. This involves a somewhat larger analysis group, N=1274, and is the set of distinct dyads identified among respondents to the survey. Thus, survey respondents were asked to name and describe up to six persons to whom they regularly turned for information and advise on farming practices (Appendix A). Among the 288 respondents who completed this section of the questionnaire, there are a total of 1274 individuals who are described, and this provides a second analysis group available for investigating the influence of the network on decisions about farming practices.

4.4.1 Normative Influence

Table 4.25 lists the mean responses for both the conserver and probability samples on several survey questions involving the perceived normative standards for soil conservation in the respondent's household and community, along with levels of reported cooperation among other household members. These responses represent the extent that the respondent perceives there to be a social climate, or attitude, which approves of and encourages conservation, while making it more achievable through levels of cooperation which exist in the household. Overall, the interpretation of the table is that respondents to the farm practices survey sense there is an expectation on the part of their friends and neighbors that they should practice conservation, and they feel some pressure to comply with this standard. The average respondent to the survey also tends to believe that others in the community do care if the respondent practices conservation, and that other community members feel obliged to practice it themselves. Finally, respondents tend to agree with other household members on issues

involving soil conservation, while also stating that in terms of most farming decisions they and their spouse usually see eye to eye.

Table 4.25

Comparison of Social Normative Factors Between Probability and Conserver Sample

Social Perception	Sample Probability mean	s.d.	Conserver mean	s.d	t	prob.
Social Norm						
Friends feel should conserve	2.44	.78	2.57	.70	-1.03	.30
Important to take advise	3.79	.75	3.96	.76	-1.49	.14
Obliged to take advise	3.00	.75	3.00	.78	.03	.98
Normative Beliefs						
Others do care	3.02	.81	2.81	1.00	1.59	.11
Others feel obliged	2.78	.70	2.57	.86	2.04	.04
Household Dynamics						
People disagree	1.53	.79	1.54	.78	-.17	.87
Differ on soil probs	1.70	.71	1.54	.86	1.41	.16
Operator & spouse agree (3 item scale, á = 69)	9.11	1.88	8.87	1.96	.77	.44

Table 4.25 suggests that the majority of farmers feel their friends and neighbors want them to practice conservation, and there are apparently few internal divisions within households to prevent this. In these respects both the conserver and probability samples are very similar, suggesting that social factors are not sufficient themselves to motivate the majority of farmers to adopt conservation. This is seen further from Table 4.26 which lists the correlations between these social network factors and the behavioural intention scale. Only the scale representing the respondent's sense that friends and neighbors feel he should be practicing conservation is positively related to behavioural intention. Thus there is some indication that farmers may pay attention to social structure factors when thinking about whether to adopt conservation tillage, but the relationship is not strong. Indeed, it can be seen that in households where there is a high level of agreement between the operator and his spouse concerning farming decisions, there is also a slight tendency not to intend to practice conservation tillage. The explanation for this is unclear, but it could be associated with the strong tie existing between farm spouses acting, to a degree, as a barrier to the receipt of new information involving innovative farming practices.

Table 4.26

Influence of Social Normative Factors on Behavioural Intention

Social Perception	Behavioural Intention r	sig
Social Norms		
SN	.23	.00
Advise	.07	.10
Oblige	.04	.27
Normative Beliefs		
Do care	.05	.19
Obliged	.02	.37
Household Dynamics		
Disagree	-.07	.11
Hard time	-.02	.37
Wife coop	-.15	.01

Table 4.27 provides mean scores on the importance of various information sources on which the respondent may rely when considering new farming practices. It is apparent from this table that the means exceed the midpoint on the five item scale of importance in every case, suggesting that farmers regard each of the listed sources as important. Nevertheless, there are no statistically significant differences between the probability and conserver samples on

these factors, suggesting that farmers seek information on new farming enterprises from various sources, and no particular pattern distinguishes the importance of information sources between conservers and the probability sample. Indeed the means on personal experience as a source of information are the highest in the table, implying that the decision to adopt or not to adopt new practices is largely made independently by the operator based on prior, first hand experience. The greater direct experience the conserver group has had with conservation tillage accounts in part for this group's members willingness to use it.

Table 4.27

Importance of Information Sources

Information Source	Sample Probability mean	s.d.	Conserver mean	s.d.	t	prob.
Personal experience	4.58	.74	4.62	.72	-0.35	.73
Spouse	3.29	1.32	3.10	1.15	0.91	.36
Other family	3.36	1.25	3.49	1.08	-0.71	.48
Neighbours	3.72	1.01	3.84	1.10	-0.80	.42
Farm media	3.74	.96	3.46	1.02	1.87	.06
OMAF reps	3.63	1.09	3.62	1.16	0.11	.91
Soil advisor	3.62	1.11	3.69	1.11	-0.42	.68
Experimental farms, colleges, U of Guelph	3.72	1.00	3.78	1.05	-0.41	.68
Soil and Crop Imp. Assoc.	3.78	1.02	3.96	1.06	-1.20	.23
Farm organizations	3.39	1.10	3.45	.99	-0.39	.69
Company reps	3.55	1.00	3.44	1.04	0.70	.48

4.4.2 Network Structure

Table 4.28 provides some summary information on the networks of respondents to the farm practices survey. These are people named by the operator as those he turns to for information while making farming decisions. The table indicates that the average size of the networks of the conserver sample, 5.52, is significantly larger than those in the probability sample, 4.39 ($t=-4.34$, $p.<.01$). This is consistent with much network theory which argues that larger networks, providing both more sources of information and more channels by which it can be transmitted to individuals, are, all and all, more amenable to the diffusion of innovation. There is also somewhat greater likelihood that the conserver will have known people in the network for shorter periods, but the differences are not large and, in any case, most network members have been known to the operator for longer than ten years, irrespective of sample. There are no significant differences in how often the respondent talks to network members, with the majority of members being talked to a least once a week. Nor are there significant differences on the occupations of individuals named in the network. The majority, 64 percent, are active farmers, followed by representatives of commercial or financial agencies, 17 percent, and by government agricultural representatives, 7 percent.

Table 4.28

Characteristics of Networks

All Network Responses	Sample Probability mean	Conserver mean	s.d.	Conserver mean	s.d.	t	prob.
Number of people	4.58	4.39	1.76	5.52	1.23	-4.34	.00
Proportion of People							
Known < 1 year	.01	.01	.07	.01	.04	0.24	.81
1 to 3 years	.09	.08	.16	.13	.16	-1.87	.06
4 to 6 years	.08	.08	.15	.14	.16	-2.60	.01
7 to 10 years	.09	.09	.19	.08	.16	0.29	.77
> 10 years	.71	.73	.29	.62	.30	2.29	.02
Talked to every day	.28	.29	.30	.26	.24	.49	.62
- about once a week	.25	.27	.29	.19	.20	1.84	.07
- at least once a month	.25	.25	.26	.25	.21	0.01	.99
- a few times a year	.18	.18	.25	.22	.22	-1.11	.27
- 1 or 2 times a year	.05	.04	.12	.07	.17	-1.47	.14
Active farmers	.64	.64	.30	.63	.28	0.09	.93
Inactive/retired farmers	.06	.07	.16	.05	.08	1.05	.30
Government rep	.07	.07	.18	.10	.14	-0.99	.33
Commercial/financial	.17	.17	.23	.15	.19	0.72	.47
Not involved in farming	.04	.04	.15	.02	.07	1.05	.30
Other farm involvement	.02	.03	.12	.02	.06	0.72	.48

The survey also asked respondents to indicate which individuals named in the network they turned to for information on several specific farming matters -- improvements to land and buildings, tillage and cropping practices, finances and machinery. Respondents were asked to indicate who in the network was most valued as a source of information on these topics, as well as to report what other network members were talked to, but whose opinions were less important, or if they talked to no one on such matters.

Table 4.29 lists the proportion of network members turned to for advise on each of these specific farming concerns. There are, again, very few differences between the probability and conserver samples. On average, twenty-nine percent of the respondent's network members were listed as being very important sources of information with respect to proposed improvements to the land, twenty percent were turned to for advise on building improvements, thirty-three percent on tillage practices, thirty-four percent on cropping practices, twenty-two percent were turned to for financial advise, and twenty-nine percent provided information on machinery.

Relatively small proportions of farmers talked to no one in their network concerning these topics. However, of these there were significant differences among the probability and conserver groups with respect to cropping and tillage practices, and on information about machinery. Only two percent of the conserver group talked to no one in their network on these matters, whereas for the probability sample the proportions ranged between thirteen and twenty percent. This may suggest that it is not how many people in the network one talks to about

cropping and tillage which is important to conservation adoption, so long as one talks to someone. Still, given the general inability of the network factors to distinguish between the two samples, such a conclusion must treated as extremely tentative at this time.

Finally, Table 4.29 again suggests no differences between members of the two samples on the question of whether people in the network are reported to practice conservation, or to be a member of a farming group which promotes it. A relatively high percentage of the network membership, 41 percent, is reported to either practice conservation or belong to an organization which encourages it, but neither sample can be seen to have a greater representation of such members.

Table 4.29
Consultation of Specific Farming Practices

Farming Topic	All Probability mean	All Probability mean	Sample Conserver s.d.	Sample Conserver mean	Sample Conserver s.d.	t	prob.
Important People (proportion)							
Land Improvement							
most important	.29	.30	.26	.28	.24	0.41	.68
also important	.12	.11	.18	.15	.21	-1.54	.13
Building Improvement							
most important	.20	.21	.25	.19	.19	0.51	.61
also important	.07	.07	.16	.08	.12	-0.30	.77
Tillage Practices							
most important	.33	.32	.29	.38	.26	-1.31	.19
also important	.12	.11	.20	.14	.19	-0.69	.49
Cropping Practices							
most important	.34	.34	.29	.33	.22	0.31	.76
also important	.13	.13	.20	.16	.21	-0.90	.37
Financial Matters							
most important	.22	.22	.23	.22	.19	0.11	.92
also important	.07	.06	.15	.12	.20	-2.31	.02
Machinery							
most important	.29	.28	.26	.32	.23	-1.00	.32
also important	.10	.09	.18	.14	.20	-1.60	.11
Talk to No One							
Land Improvement	.14	.14	.35	.11	.32	.60	.55
Building Improvement	.31	.31	.46	.28	.46	.38	.70
Tillage Practices	.14	.16	.37	.02	.15	2.51	.01
Cropping Practices	.11	.13	.34	.02	.15	2.13	.03
Financial Matters	.21	.22	.42	.17	.38	.73	.47
Machinery	.17	.20	.40	.02	.15	3.01	.00
Proportion of Network							
Known conservers	.41	.40	.25	.42	.25	-0.43	.67
Member of groups promoting conservation	.41	.39	.25	.46	.26	-1.25	.21

Table 4.30 compares two structural aspects of the networks from the farm practices survey -- the number in the network and the network density -- on factors relating to tillage practices, erosion conditions, and farm, farm operator and financial characteristics. The coefficients are Pearson product moment correlations between network size (the number of individuals named by the farmer as comprising the network) and density (the proportion of potential to actual reciprocated ties) and several factors constituting important behavioural, geographic, economic and socio-demographic conditions of the farm operation. As was shown earlier, the conserver sample is significantly more likely to have larger networks. In addition the size of the network is positively associated with the likelihood of having used conservation tillage in 1987, as well as with the intention to practice conservation and with the perception that erosion is a problem on the farm. The explanation for this is that larger networks probably enable more effective communication through additional information sources and channels, thereby encouraging awareness of erosion conditions and encouraging conservation adoption.

On the other hand, the density of the network is negatively associated with membership in the conserver sample (non-significant), and with 1987 tillage practice, behavioural intention and the perceived erosion scale. Once again this is consistent with the understanding that dense networks, constituted of a greater connectiveness, are also more "closed", thereby potentially inhibiting the entry of information on new farming practices or, if this is not the case, perhaps being comprised of more homophilious relations acting to resist information on novel farming techniques.

Large networks are also positively associated with younger and better educated farm operators, and with those with more debts, earning less return on investment and with less acreage. Density, however, is unrelated to these other aspects of the farm and its operator. Overall, therefore, the structural characteristics of the network permit some further understanding of the decision to adopt or not adopt conservation tillage.

Table 4.30

Fact Relating to Network Indices

Factor	Network Size r	sig	Density r	sig
Sample	.25	.00	-.03	.41
1987 tillage practice	.13	.03	-.11	.04
Behavioural intention	.16	.01	-.08	.09
Erosion index	.11	.04	-.16	.00
Total acreage	-.11	.04	-.05	.35
Return on investment	-.15	.02	-.02	.44
Total debt	.22	.00	-.07	.15
Operator's age	-.24	.00	-.03	.40
Operator's education	.13	.02	-.01	.46

4.4.3 Influence of Strong Ties

We now turn to the analysis of the characteristics of the 1274 unique dyads possible to extract from the networks of respondents to the survey. These represent the one to one relations existing between the farmer and each individual named in his network. Thus the unit of analysis shifts from the network and the operator to the relationship between operators and individuals named in the network. In this connection an indication of variability in the utility and importance (or value) of network members as sources of information for farmers is obtained by scoring the absence or placement of each of the 1274 dyads identifying members whose opinions are most important when considering changes in land, building, cropping, tillage finances or machines. Placement as "most important" is scored higher than "also important", and a ranking obtained for every dyad (Appendix B). The network number is not controlled for by this calculation because farmers were not restricted in the number of people they could enter in any cell of the grid, nor in the number of times a particular person could be mentioned. Some farmers said they talked to no one on some of the issues. Overall, when a farmer consulted some member of the network on one or more of the six topics, approximately 24 percent of possible nodes were never mentioned as important, while the "most mentioned" emerged approximately 18 percent of the time, leaving about 58 percent of the dyads mentioned but infrequently.

Table 4.31 provides several comparisons of this scale against factors used to distinguish adopters and non-adopters -- the sample, behavioural intention and the 1987 tillage practice. The non-significance chi-square tests associated with both the sample and the 1987 tillage

practice factors, and the lack of a clear pattern for behavioural intention suggests it would be wrong to attempt to generalize a finding that either conservers or non-conservers, however scored, tend to refer to their network more or less often. Nevertheless these tables do prompt further examination and description of the dyads that are important information sources.

Table 4.31
Importance of Opinions to Conservation Adoption

Importance on Selected Topics	Sample Probability Dyads	%	Conserver Dyads	%	All Farmers Dyads	%
No mention	232	23.1	69	25.6	301	23.6
Little mention	355	35.4	82	30.4	437	34.3
Some mention	237	23.6	74	27.4	311	24.4
Most mention	180	17.9	45	16.7	225	17.7
Total	1004	100.0	270	100.0	1274	100.0

Chi-square = 3.535 (d.f.=3)
Sig = .32

Importance on Selected Topics	1987 Tillage Practices: Conventional Dyads	%	Conventional & Conserving Dyads	%	Conserving Dyads	%	Total Dyads	%
No mention	107	21.3	110	22.9	68	26.9	285	23.0
Little mention	172	34.2	180	37.4	80	31.6	432	34.9
Some mention	142	28.2	107	22.2	56	22.1	305	24.7
Most mention	82	16.3	84	17.5	49	19.4	215	17.4
Total	503	100.0	481	100.0	253	100.0	1237	100.0

Chi-square = 9.338 (d.f.=6) Sig = .16

Importance on Selected Topics	Behaviour Intention: Definitely Not Intended Dyads	%	Probably Not Intended Dyads	%	Probably Do Intend Dyads	%	Definitely Do Intend Dyads	%	Totals Practice Dyads	%
No mention	119	24.7	21	30.4	23	23.0	4	14.8	133	23.3	300	24.0
Lit. ment.	158	32.8	25	36.2	39	39.0	17	63.0	190	33.3	429	34.4
Some ment.	122	25.4	10	14.5	29	29.0	4	14.8	138	24.2	303	24.3
Most ment.	82	17.0	13	18.8	9	9.0	2	7.4	110	19.3	216	17.3
Total	481	100.0	69	100.0	100	100.0	27	100.0	591	100.0	1248	100.0

Chi-square = 21.81 (d.f.=12) Sig = .04

Table 4.32 provides an overview of characteristics of individual network nodes for all dyads and nodes on all levels of mention. Our interest is mainly in the most mentioned dyads, with the other categories presented for purposes of comparison. First, in comparison to farming involvement, 89.1 percent, or almost all, of the most important nodes are active farmers. In other words, they are similar to the respondent. But because active farmers are a large number, 66.4 percent of all nodes, the most mentioned nodes contain only 16 percent of actively farming nodes. Second, if the farmer has indicated the presence of conservers in the network, the most important are more likely to be conservers, who are 57.9 percent of this most mentioned group, than to be nodes not identified as conservers. Third, in the 88 networks with known members of associations promoting conservation, roughly half, 49.3 percent, of the most mentioned group, are likely to be such members. The percentage is higher for the next level of mention, some mention, but much lower for the categories of no or little mention. In sum, in terms of who a farmer is likely to mention most often with respect to seeking information on important farming matters, the odds are it will be another farmer, but if a known conserver or member of an association which promotes conservation is a member of the network, then there is also the tendency for such individuals to be referred to.

Table 4.32
Characteristics of Network Members by Importance to Farmer on Selected Farming Topics

	Importance on Selected Topics								Totals	
	No Mention		Little Mention		Some Mention		Most Mention			
	Dyads	%	Dyads	%	Dyads	%	Dyads	%	Dyads	%
Farming Involvement										
Active farmer	144	53.3	244	58.2	218	72.9	196	89.1	802	66.4
Retired or Inactive	29	10.0	28	6.7	22	7.4	12	5.5	89	7.4
Government rep	18	6.7	34	8.1	24	8.0	7	3.2	83	6.9
Commercial or financial rep	63	23.3	97	23.2	30	10.0	3	1.4	193	16.0
Not involved	18	6.7	16	3.8	5	1.7	2	.9	41	3.4
Total	270	100.0	419	100.0	299	100.0	220	100.1	1208	100.1
Chi-square (d.f.=12) = 113.9 Sig = .00 Cramer's V = .18										
Conservation Tillage										
Known conserver	32	20.9	58	25.1	84	48.3	70	57.9	244	35.9
Not known to conserve	121	79.1	173	74.9	90	51.7	51	42.1	435	64.1
Total	153	100.0	231	100.0	174	100.0	121	100.0	679	100.0
Chi-square (d.f.=3) = 63.51 Sig = .00 Lambda = .06										
Membership in Association Promoting Conservation										
Known member	21	21.4	39	26.2	69	54.8	36	49.3	165	37.0
Not known to be member	77	78.6	110	73.8	57	45.2	37	50.7	281	63.0
Total	98	100.0	149	100.0	126	100.0	73	100.0	446	100.0
Chi-square (d.f.) = 39.49 Sig = .00 Lambda = .101										

* Totals not equal to 100 because of rounding

Table 4.33 presents further information on how networks may influence the assimilation of information on new farming practices. Once again the interest is mainly in the most mentioned category, with the other categories presented for comparison. The three distributions representing the member's relationship to the farmer, length of time known and frequency of interaction present clear pictures, and provide information to establish the strength of weak ties. Kin and active farmers are more or less homophilous (similar) ties. The length of time the relationship with the farmer has existed and how often conversation occurs are both indicators of opportunity for information to be exchanged. In the first frequency, immediate family and kin are obviously disproportionately present. While 37.6 percent of all dyads are family and kin (and the next largest group, at 25.9 percent, is friends), 66.1 percent of the most mentioned are family or kin.

In the second distribution, the most mentioned ties are relationships of long duration, with 85 percent known by the farmer for more than 10 years, and less than 1 percent for less than one year. The pattern holds for the frequency of interaction: among all dyads 25.9 percent talk to the farmer every day, while for the most mentioned it is 54 percent.

It is, of course, no surprise that farmers name their family and kin as members of their network, and when then do report as well that they have known them for a long time and speak to them frequently. What is important are these reports in connection with whom they claim to refer to on matters of specific farming practice. When it comes to deciding something on the farm, the reference group is family, kin, and other farmers, all individuals with whom the

farmer, on grounds of obvious similarity, is strongly connected. Obviously such individuals will usually play a role in one's personal network. However, their relationship to the farmer, similarity, and in the case of family and kin, ready accessibility, allows them influence disproportional to their numbers with respect to farming decisions. On the majority of issues this may not matter, or it may even be desirable, but if the issue is one of whether to adopt a new and innovative farming practice, such as conservation tillage, networks constituted of member similarity and strong ties tend, on the whole, to counteract the chances of adoption.

Table 4.33

Relationship of Network Member with Farmer by Consultation on Selected Farming Topics

	Importance on Selected Topics								Totals	
	No Mention		Little Mention		Some Mention		Most Mention			
	Dyads	%	Dyads	%	Dyads	%	Dyads	%	Dyads	%
Relation to Farmer[1]										
Family and kin	96	31.9	126	29.0	107	34.5	148	66.1	477	37.6
Friend	78	25.9	104	23.9	98	31.6	49	21.9	329	25.9
Neighbour	23	7.6	41	9.4	23	7.4	9	4.0	96	7.6
Chi-square (d.f.=6) = 43.81 Sig = .00										
Length of Time Known[2]										
< 1 year	4	1.4	7	1.7	8	2.6	2	.9	21	1.7
1 to 3 years	23	8.2	60	14.2	27	8.8	7	3.2	117	9.5
4 to 6 years	23	8.2	53	12.6	26	8.4	14	6.4	116	9.4
7 to 10 years	21	7.5	36	8.5	33	10.7	10	4.5	100	8.1
> 10 years	210	74.7	266	63.0	214	69.5	187	85.0	877	71.2
Total	281	100.0	422	100.0	308	100.0	220	100.0	1231	99.9
Chi-square (d.f.=12) = 46.26 Sig = .00 Lambda = .00 Cramer's V = .11										
Frequency of Talking[2]										
1 to a few times times a year	81	28.5	131	30.6	56	18.1	14	6.3	282	22.7
At lease once a month	75	26.4	115	26.9	94	30.4	36	16.1	320	25.7
Abt. once a week	72	25.4	112	26.2	84	27.2	53	23.7	321	25.8
Every day	56	19.7	70	16.4	75	24.3	121	54.0	322	25.9
Total	284	100.0	428	100.1	309	100.0	224	100.1	1245	100.1
Chi-square = 145.50 (d.f.=9) Sig = .00 Lambda = .00 Cramer's V = .20										

[1]Totals not equal to 100% because categories not exhaustive or mutually exclusive
[2]Totals not equal to 100% because of rounding

5.0 SUMMARY AND CONCLUSIONS

Our object has been the investigation of factors influencing the farm operator's decision to adopt or not to adopt conservation tillage. The basic proposition which underlies our approach to this problem is that the farmer's decision in this regard is multidimensional requiring that a constellation of influences be understood. Our approach, therefore, has been to analyze several vectors of presumed importance to this decision while comparing survey responses from a representative probability sample of mainly grain corn operations in the SWEEP project area with responses from a non-probability sample of known conservers. In this way we have attempted to isolate those factors within the range of farming experience which influence positively or negatively the adoption of innovation.

Among the dimensions investigated is the social sphere of influence as constituted by operator's personal network acting as a frame of reference to which he refers when deciding between important farming choices. The influence of such a network on decision-making is examined along with other significant geographical, economic, social-psychological, and socio-demographic characteristics of the farm and the farm operator. The introduction of the social network represents a new development in the effort to understand the diffusion of innovation in the context of the adoption of conservation tillage.

On the basis of this investigation, the following conclusions appear warranted:

1. The decision to adopt conservation tillage is multi-faceted. Across the range of dimensions investigated it was nearly always the case that one or several factors stood

out to distinguish members of the probability sample from the conserver group, or to identify conservers. Some of these -- education, age of operator, farm size, etc. -- are already widely known based on the forty year research tradition in rural sociology on diffusion of innovation. Other factors, particulary those relating to attitudes, social normative beliefs, and network factors, are much less often recognized. However, their relationships with adoption were in several cases larger than some of the more commonly cited predictors of conservation tillage. Nor could it be claimed that there is any consistent pattern among significant variables. Conservers do not score "high" on a package of attributes while non-conservers score "low", or vice versa. Thus farmers make up their minds to practice conservation or not to practice it in consideration of many things, and singularly focused programs to promote conservation which rely on a single dimension of the decision framework are no likely to be very successful.

2. Conservation adoption is unpredictable. In spite of a number of significant associations across several dimensions, the correlations were, for the most part, not sizeable. Correlation coefficients in the range of .12 to .20 were common and, while statistically significant, can hardly be regarded as noteworthy by their abilities to explain variability. Any review of the literature on soil conservation (e.g., Nowack, 1987; Carlson and Dillman, 1983) will indicate the presence of correlations in this range being far from unusual. In the current analysis correlations in the vicinity of between .20 and .30 were common also, but those in the range .31 to .40 occurred only occasionally, and those above .40 infrequently. We have not attempted to maximize explained variability in

adoption by combining all the significant factors in a multivariate model but, given the level of interdependencies between these factors, it seems hardly likely that any regression would account for more than 20 percent of the variability in adoption, and probably less. Given the multifaceted measurement thrust of the survey instrument, it should probably be admitted that future approaches are not likely to do much better, and we should accept that identifying conservers on the basis of their farms, or socio-demographics, or beliefs and attitudes, or social networks, or anything else, is never going to be easy.

3. There was little from this analysis suggesting the financial conditions of the farm to be related to conservation. Large farms are more likely to use conservation, true, but several financial indicators were unrelated to conservation, while adopters also had significantly lower returns on investment and higher debt. Thus it would be hard to conclude that adopters conserve because they are more able to afford it. The one factor which strongly predicts the intention <u>not</u> to adopt conservation tillage, was the belief that such practices were uneconomical. We are not economists or accountants and on the basis of the data collected there is no way of telling whether such a belief is warranted for particular farms. The point is, whether site justified or not, many farmers do not practice conservation because they believe it to be uneconomical, and it appears they may be justified in this belief given recent financial analyses which have questioned whether conservation can be made economical except under the most ideal conditions.

On both of the above grounds it should be concluded that programs to encourage conservation based on its questionable financial benefits are misguided. It often appears that in developing programs to promote soil conservation, planners have assumed the need to convince farmers of its financial benefits, either on grounds of increased yields, lower production inputs or qualification for government subsidies. However, an important factor predicting adoption of conservation practices in this survey was the farmer's moral commitment to conservation, and it is notable that such a factor was additionally inversely related to the belief that conservation was uneconomical. Apparently farmers will conserve for nonpecuniary reasons, as a number reported doing in this survey, and given the debatable economic merits of conservation tillage, soil preservation in Ontario may in the long run be better served by replacing an emphasis on economic returns with one which stresses land stewardship.

4. According to our admittedly somewhat liberal definitions of adoption, more farmers in Ontario may be practicing conservation that was previously believed. Among the probability sample 12.9 percent of farmers reported using only conservation tillage on their farms in 1987, and a further 35.7 percent combined conventional tillage with conservation tillage. In addition 44.1 percent of the respondents in this sample reported either now practicing conservation tillage, or intending to practice it in the near future. Other measures on the belief in the existence of soil problems in Ontario, the need to practice conservation, and on the sense that members of the farming community expected the operator to practice conservation were also agreed to by a majority of the

respondents. It is possible that even sensitivity toward soil problems may be insufficient motive for adopting conservation, as other studies have suggested, and the great majority of farmers in this sample, 86.5 percent, still did use the conventional moldboard plough in the fall on at least some portion of their farm in 1987 (the proportion of affected acreage was .675). Nevertheless, on balance, there is still evidence here of concern about soil problems in Ontario by most farmers, followed by intention to conserve and actual, if limited, conservation in nearly one-half of the cases.

5. A factor which appears consistently related to the likelihood of adoption is the farmer's perception that soil loss is occurring on his own farm. The differences between the conserver and probability sample in this regard may be due to actual site differences existing between the farms of the two samples, but is also suggestive that the farmers in the conserver sample are better able to recognize erosion when it occurs. Why this should be so is unclear, but it is worth noting that elsewhere in the survey farmers identify their most important source of information to be their own past experience. The belief that significant soil loss is occurring on one's own farm is a necessary condition to taking steps to prevent it. However, farmers cannot believe in soil loss until they experience it, and cannot experience it until the phenomenon is understood and recognized. If more farmers could be shown how to directly recognize soil erosion and be able to estimate its cumulative effects on their own farm, they would believe in soil erosion and practice conservation.

6. An important purpose of this research was to investigate the influence of the farmer's social network on his decision to adopt or to not adopt conservation tillage. It would be nice to end with the claim that important new insight and understanding in the area of diffusion of innovation has been achieved by this inclusion, but the findings do not warrant such a conclusion. The findings are suggestive, but not conclusive. The structural properties relating to size and density of the network may be related to the rate of dissemination of new information, as well as influencing the network's receptiveness toward innovative farming technology. The networks in our sample were also characterized by highly homophilous and strong ties, and it is likely that such properties have the function of both restricting the entry of novel information as well as impeding approval for risky, new farming practices. However, our comparison of adopter and non-adopter networks revealed little which could be seen to distinguish their behaviours, with the exception that the networks of adopters were larger. On balance there is little to suggest at this time that there are properties of the farmer's social network enabling achievement of important new understanding of the diffusion of innovation phenomenon. Still, it needs to be pointed out that the network variables in this research introduce a new level of analytical complexity which is still in the formulation stage, and with continued investigation these variables remain potentially rich in their ability to explain diffusion.

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APPENDICES:

- Farm Practices Survey

- Attitude and Social Structure Variables